BUILDING YOUR FIRST

RADIO CONTROL AIRPLANE

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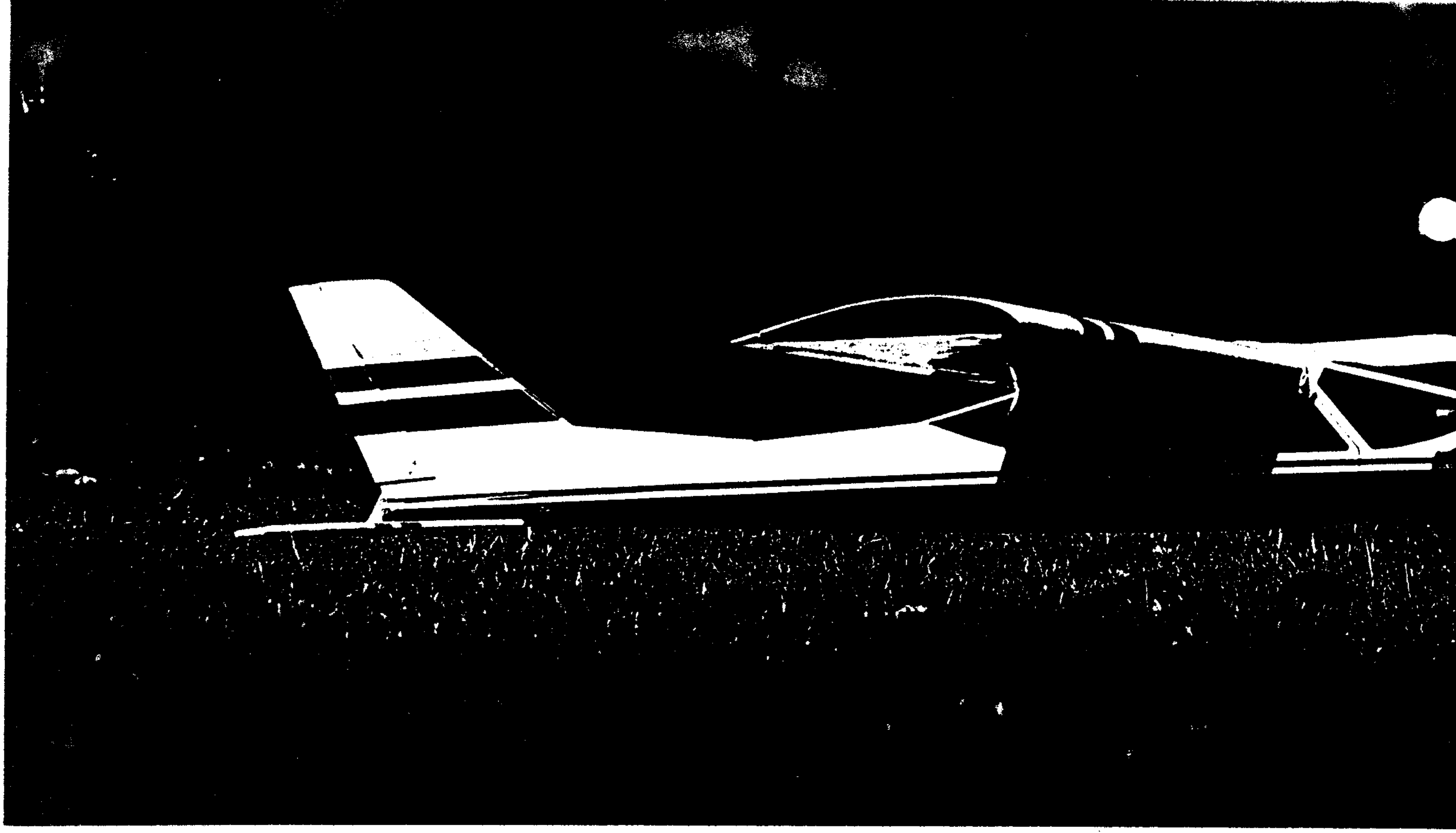
KALMBACH BOOKS

Published by Kalmbach Publishing Co., 21027 Crossroads Circle, P. O. Box 1612, Waukesh WI 53187. Printed in U. S. A. Library of Congress Catalog Card Number: 89-84727. ISBN: 0-89024-09



1. Getting started

Our first order of business is to define two terms. I'll call the construction manual that comes with your kit THE MANUAL to distinguish it from this book, which I'll call THE BOOK.

The next order of business is to get you an airplane kit. Any of the ones covered in THE BOOK will do the job, but before choosing one, read Chapter Two (Buying the Right Stuff), which describes each airplane. Then visit a hobby shop and buy your kit. While you're there, it won't hurt to purchase a copy of one of the popular radio control magazines such as *Model Aviation* or *R/C Modeler*. Resist the temptation to buy anything else on your first visit.

Before leaving the shop ask how to contact the local RC club. You'll need its field and its instructors to learn to fly.

Also, many hobby shops carry AMA (Academy of Model Aeronautics) application forms. Take one and join the AMA. Membership provides a variety of benefits, not the least of which is liability insurance. If you can't get an AMA form at the hobby shop, turn to the back of THE BOOK for the AMA's address.

Take your kit home and open it up but don't start cutting and gluing yet. Study the plans and read THE MANUAL. Examine the kit itself and compare the hardware and materials inside with the lists in Chapter Two of THE BOOK (Buying the Right Stuff). There's also a chapter on your particular airplane, so check that, too, for additional items needed to build the kit.

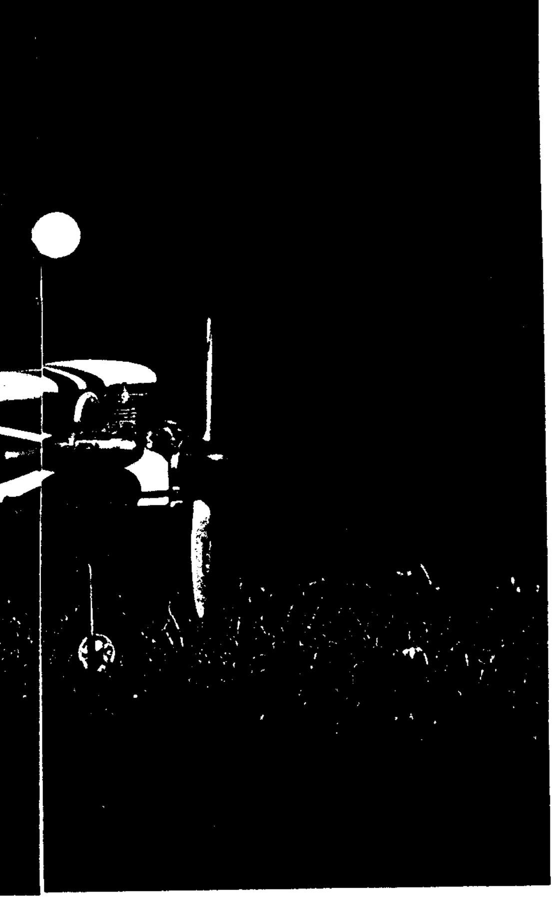
Now make a shopping list of everything you need that isn't included in the kit or that you don't have around the house, and go on a shopping binge.

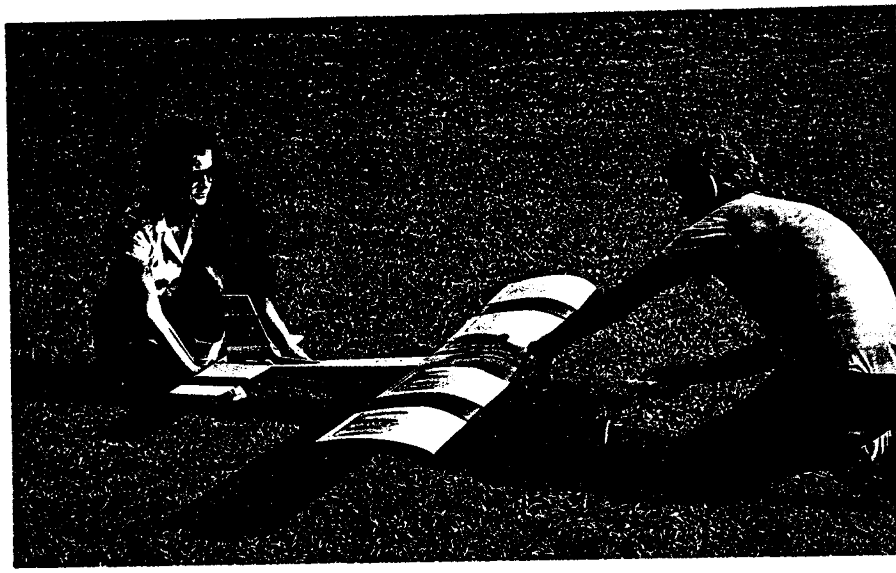
Don't settle for substitutes. All the items I've listed are readily available, and if you start substituting, you may have problems later. If one hobby shop doesn't stock an item, try another shop, or the manufacturer, or one of the mail order houses that advertise in model magazines. Whatever you do, don't get talked into the wrong engine or the wrong kind of radio system: Either can waste your time and money and make you hate model airplanes.

As you're gathering equipment, read Chapter Three (Miscellaneous Preliminaries), which discusses the work area and tells you how to make a few simple tools and how to assemble the fuel tank. Once you've finished those tasks, turn to the chapter on your airplane. There you'll discover a section on construction, which tells you how to perform operations that are not clearly explained in THE MANUAL, or that should be performed differently. Where possible, I present these topics in the order they appear in THE MANUAL. Read what THE BOOK says on these subjects, then commence framing the model, following the instructions in THE MANUAL, except where THE BOOK contradicts them.

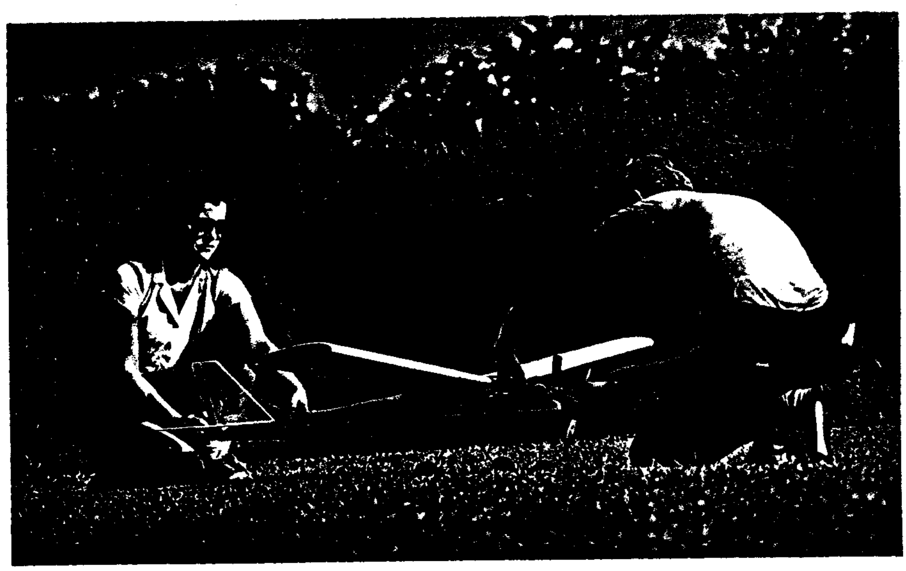
FRAMING THE MODEL

If you're building an ARF kit (Almost Ready to Fly) all you do in the





The Midwest Aero-Star 20 (above left), Goldberg Eagle 63 (above), Great Planes PT-40 (below), Goldberg Eaglet (bottom), and Royal-Air 40T (bottom left) are just some of the radio control airplanes you can build with the help of this book. I built these planes for this book and kept careful notes as I went along, which appear in the final five chapters.



"framing" stage is join the wing panels, an operation THE BOOK covers in more detail than THE MANUAL does. If you're building a conventional kit, you'll construct the wood framework and do nothing else. Read the chapter on your plane in THE BOOK before beginning each construction step so you don't miss anything. Whether your plane is an ARF or a conventional kit, ignore any instructions in THE MANUAL to cut hinge slots, install hinges, or glue the tail parts to the fuselage. Life's much simpler if you do those things later, and differently.

After framing the conventional model or joining the wings on your ARF, turn to Chapter Four (Preliminary Radio Installation). From this point on, just follow THE BOOK, which will occasionally refer you to THE MANUAL. When you complete Chapter Eight (Final Touches) charge the batteries overnight, then take the plane to the field and have your instructor check it to be sure you did not make any serious mistakes. Then fire up the engine and pretend to be cool as you watch the model bounce down the runway and climb out on its maiden flight.

Before we get started, here are a couple of cautions:

1) Some kits can be built without ailerons, but having taught RC flying for many years, I don't think that's a good idea. Aileron airplanes fly more precisely, and provided they're properly set up, allow you to learn more quickly. I've written THE BOOK assuming you'll build an aileron model. If you leave the ailerons off, some of the things I tell you to do will be wrong for your airplane. Build the ailerons.

2) RC flying is a fast-changing hobby, and manufacturers frequently modify kits and manuals. If something you read in THE BOOK makes no sense, chances are THE MANUAL or the kit has changed since I wrote THE BOOK. Use common sense in these situations. Don't do something that seems crazy just cause I tell you to.

Fig. 2-1. A few of the better trainer kits.

2. Buying the right stuff

Hobby shops offer a mountain of radio control airplane equipment and tools. Some of it is for you; lots of it isn't, at least not for now. This chapter will help you decide what is and isn't for you.

THE AIRPLANE

If you're like most people getting into radio control modeling, you have visions of yourself flying a scale P-51 Mustang or a biplane, or even a jet. There's no reason you can't eventually do all those things, but nobody starts that way. Even if you make a living flying fighter jets, a gentle radio control trainer will be a handful in the beginning. Whoever you are, you'll need a nice, stable, slow airplane to learn on.

TABLE 1: WING LOADINGS

Plane	wing loading (ounces/square feet)
Eagle 2	16.9
PT-20	17.0
Royal 40T	17.1
Eagle 63	17.5
Aero-Star 40	17.9
PT-40	18.6
Headmaster	18.6*
Eaglet 50	19.2
Aero-Star 20	19.8
Royal 20T	21.1

*** Because of its symmetrical airfoil the Headmaster is noticeably faster than other trainers of the same wing loading.**

One of the best ways to identify a good trainer plane is to check its wing loading — the weight supported by each square foot of wing area. The lower this number, the more gently the plane flies, and the easier it is for a beginner to handle. Table 1 lists the wing loadings of the planes I built for this book. You may get slightly different values, but these will give you a rough idea of what to expect from each kit. The best trainers have wing loadings below 18 ounces per square foot. Notice that only one small airplane made the cut. In this hobby, bigger is almost always better.

Not all kits look alike when you open the box. The conventional ones start out as small piles of lumber (see Fig. 2-4) while ARF (Almost Ready To Fly) kits are framed and covered at the factory (see Fig. 2-5). If you have the time and enjoy building, get a conventional kit. If you're short of time, you can buy an ARF and get into the air with half the work or less.

Most of the models discussed here come in large and small sizes (see Fig. 2-6). If there's room in your house and car, get one of the big ones. It will be much easier to see and probably will have a lighter wing loading. The following paragraphs should give you some idea of what to expect from each airplane. If I seem to go heavy on the superlatives, it's because I chose only the best models I know. Some terrible dogs are out there masquerading as trainers, but you won't find them here.

Conventional Planes

Goldberg Eaglet, Eagle 63, and Eagle 2: This basic design has been around for quite a few years because it's good. The Eaglet is the small version; the Eagle 63 (see Fig. 2-7) is the outgoing larger version of the same design and is being replaced by the Eagle 2, which looks the same, but flies even better.

The Eagle trainers are my favorites — especially the Eagle 2. To my eye they're the prettiest of the lot. They're also light, easy to build, and they fly well. I don't know a trainer that handles better than the Eagle 2.

Its takeoffs are smooth, there's almost no tendency to bounce on landing, and the Eagle trainers are capable of decent aerobatic performance. They don't perform outside loops as well as some others, but they'll do inside loops, Cuban eights, and even respectable

Figs. 2-2 and 2-3. These are good planes, but not for the novice.

four-point rolls. The only bad rap on the Eaglet 50 and Eagle 63 is that they tend to pitch up too sharply when you suddenly apply power. The Eagle 2 doesn't have that problem.

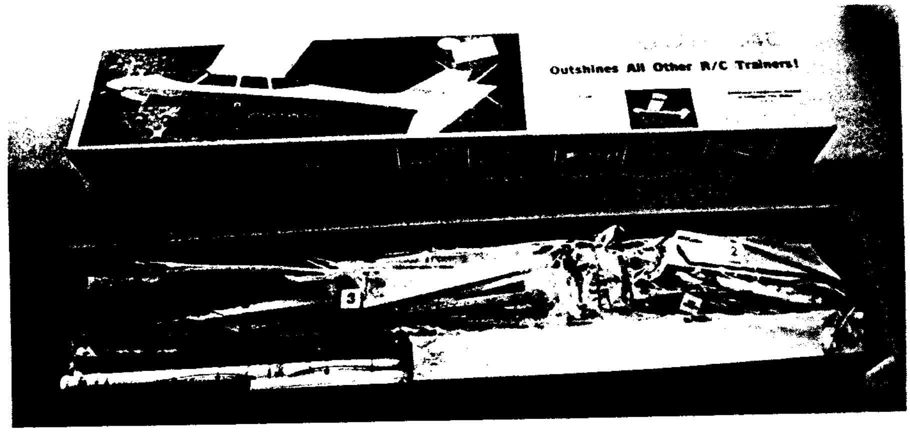


Fig. 2-4. A conventional kit is mostly lumber.

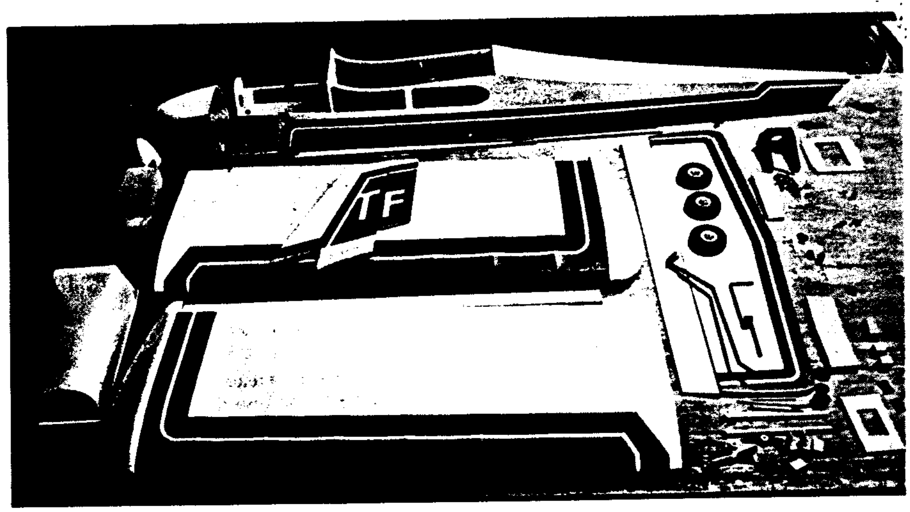


Fig. 2-5. ARF kits come out of the box already framed, covered, and decorated. They take about half as long to build as conventional kits.

Great Planes PT-20 and PT-40: Both of these planes are fun to fly because once you've trimmed them properly and have gained a couple of hundred feet of altitude, they'll right themselves from any mess you get them into (see Fig. 2-8). When I've allowed my PT-20 and PT-40 to take off on their own, both have done fine. They'll almost land themselves smoothly — but not quite. I've tried that a few times and they've always flipped over. Of course I had to line them up with the runway before letting them land, and the beginner doesn't have a prayer of doing that. Even with these stable

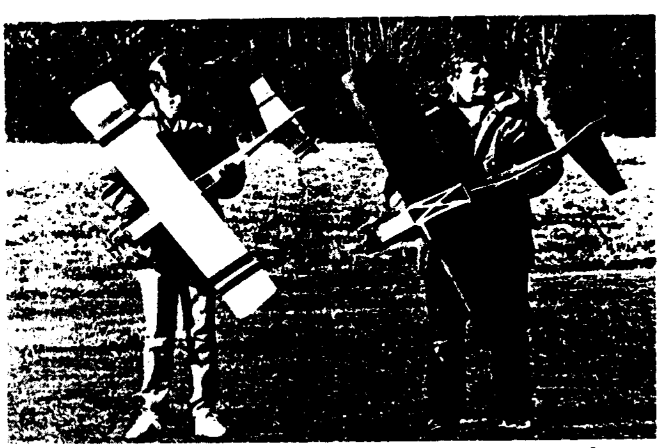


Fig. 2-6. These planes are both Midwest Aero-Stars, but because the larger Aero-Star (40) flies slower and is easier to see, it's a much better first airplane. In general, bigger trainers make learning easier.

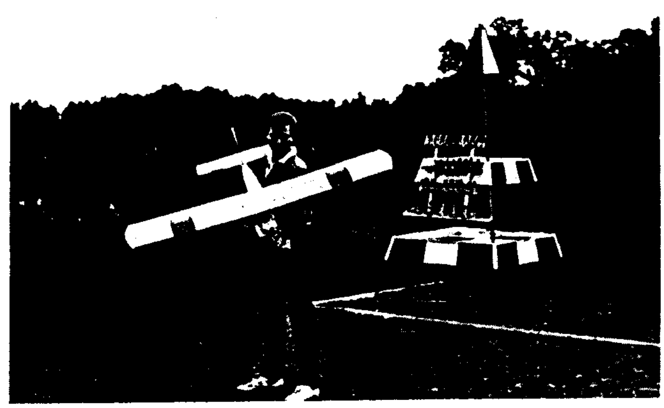


Fig. 2-7. This Goldberg Eagle 63 looks just like the newer Eagle 2 and the smaller Eaglet 50. All fly well, but the Eagle 2 is the bes'

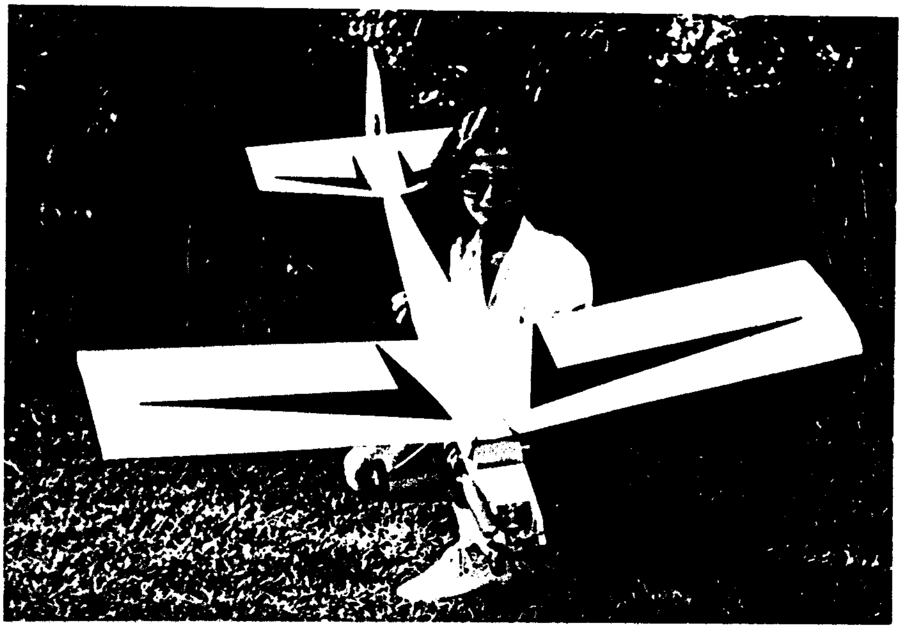


Fig. 2-8. The Great Planes PT-40 shown here and the smaller PT-20 are among the easiest planes to fly because if you get in trouble and just let go of the controls, the plane will right itself into a level glide. Then, if you add a little power, it will climb back to its original altitude as if nothing had happened. If you have to start with a smaller model, the PT-20 may be your best bet.

planes, you'll still need an instructor.

The PT planes pay a price for their stability, though. They don't respond as precisely as most trainers, and with their large dihedral angles, they're easily blown over on takeoff or landing by even a moderate crosswind. Regardless, they're the easiest four-channel planes to fly. I'd especially recommend them to anyone who has to learn RC flying with little or no help from an instructor. (I'd also recommend you move mountains to get help from someone who knows how to fly rather than go it alone. Teaching yourself is expensive, frustrating, and potentially a hazard.)

Midwest Aero-Star 20 and Aero-Star 40: This is another clean flying design. The smaller version is about as fast as I like a trainer to get, but the larger one is nice and slow and gentle. Both fly well at altitude and handle bumpy weather conditions better than most trainers. Both take off nicely, but my Aero-Star 20 (see Fig. 2-9) has a tendency to bounce if I don't hit the landing just right. The Aero-Star 40 lands fine. THE MANUAL for both runs to more than 100 pages and leaves little room for error in framing the plane. The quality of the die-cutting on my Aero-Stars was the best I've seen. I'd rate the smaller version of this plane as a good trainer and the larger one as excellent.

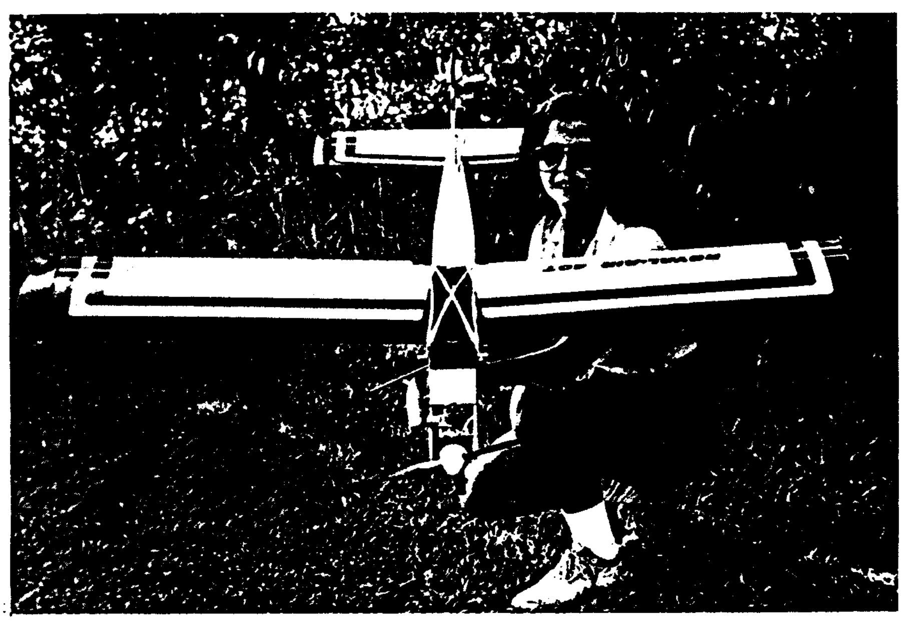


Fig. 2-10. The Royal-Air 40T is by far the easiest plane in this book to build. It's also among the easiest to fly. The smaller 20T flies well, too, but noticeably faster.

Almost Ready to Fly Models

Royal-Air 20T and Royal-Air 40T: The Royal-Air 40T is the best ARF trainer I've flown and the easiest plane in this book to build (see Fig. 2-10). It flies slowly, looks good, and has no bad habits that I could detect. I'd rank its flight performance with the best conventionally built trainers. If you choose an ARF, the 40T is probably your best bet. The 20T also builds easily and flies well, but it's faster than the 40T, and like most small planes, isn't as forgiving of beginner error.

Top Flite Headmaster: I love my Headmaster (see Fig. 2-11), mostly because it comfortably flies maneuvers beginners shouldn't try — for example, the old Figure-M with quarter rolls. With its symmetrical airfoil it's fully aerobatic, yet won't surprise you by snap rolling just because you stall it. In that sense it's an excellent trainer. However, it's faster than most of the airplanes covered here, so don't buy one unless you have a patient instructor who'll stay with you until you can handle it. It will take longer to learn the basics, but after you solo and gain some confidence, the Headmaster will be more fun to fly and will continue to challenge you when other trainers leave you bored. It's a good choice for teenage pilots who learn faster than the over-20 crowd, or as a second plane for the non-teenager.

THE ENGINE

Two popular kinds of engines are on the market — the old reliable RC two-stroker (make sure it's an RC engine with a throttle, not a control-line engine without one), and the popular four-stroke engine (see Fig. 2-12). Buy a two-stroker for your first plane. It's reliable, simple to operate, and relatively cheap. It gives you more power for the weight, is less finicky than the four-stroker, and probably is safer to use. Your engine should come with a muffler, and the muffler should have a pressure fitting on it (see Fig. 2-13). There is a variety of substitute mufflers, many of them worthless. Get the equipment designed for your engine by that engine's manufacturer.

What Size?

Some kit manufacturers recommend engines that don't have enough power for safe takeoffs, especially from grass fields. You need enough power to pull the plane off the ground with lots of extra speed. Takeoffs with underpowered airplanes are touchy for the expert — and much worse for the novice. The chapter on your plane tells you what

Fig. 2-9. This Midwest Aero-Star 20 looks pretty and flies well, but the larger Aero-Star 40 is more docile and easier to land smoothly.

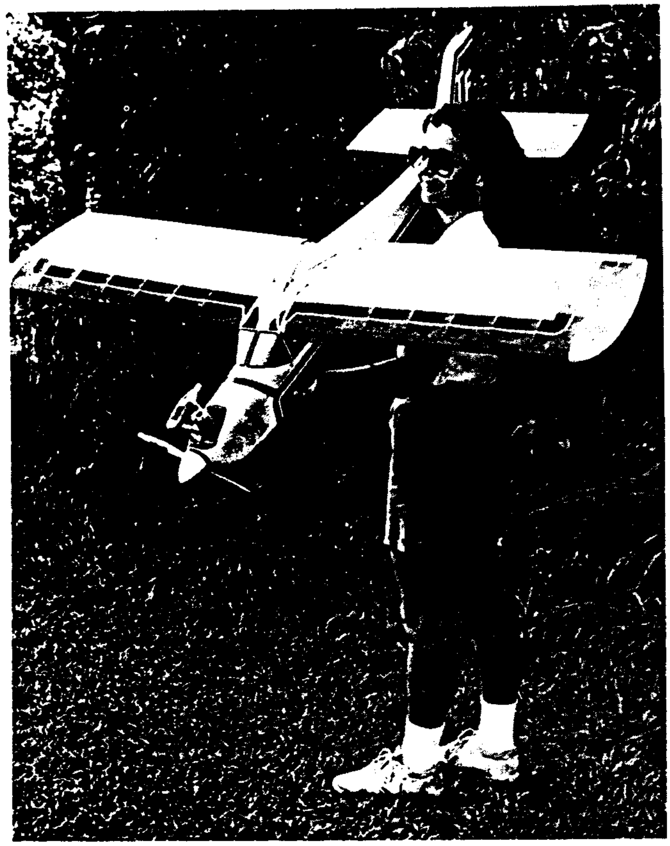


Fig. 2-11. The Top Flite Headmaster ARF flies circles around most trainers because of its symmetrical airfoil. If you're older than 18, however, it may be a little hot to learn on. It makes an excellent second plane.

size engine you need. Don't use a smaller one, no matter what THE MANUAL says, and unless your field is at high altitude, don't use one that is much bigger.

An engine strong enough for good grass field takeoffs is going to pull your plane too fast if you leave the throttle wide open after takeoff. Your instructor should teach you to throttle back on reaching altitude. If he doesn't, remind him. It's a lot easier to learn on a slow plane than a rocket.

What Brand?

It's hard to recommend a specific brand because manufacturers are always changing designs. If possible, visit the club field and see what works best there. I've had good luck with Supertigre, Fox, O. S., Royal, and K & B but there are other good ones on the market.

THE RADIO SYSTEM

This is the most expensive single purchase you'll make, and the wrong equipment here, no matter how cheap, will lead to a catastrophe. That doesn't mean you have to buy the top of the line, but your system has to be appropriate to your needs. Here's what to look for when you go to buy your radio:

1) 1991 certification: As of January 1991, more than twenty new "aircraft only" frequencies will become legal. This will reduce frequency separation between adjacent 72 MHz RC channels from 40 KHz to 20 KHz. To fly in this environment, you'll be required by the flying club to use narrow-band equipment. If you don't have it, you could easily lose your plane, or worse, shoot down someone else's plane. By the time you read this book, all new radio sets should be 1991 certified. Just be sure you don't buy a leftover that's no longer safe.

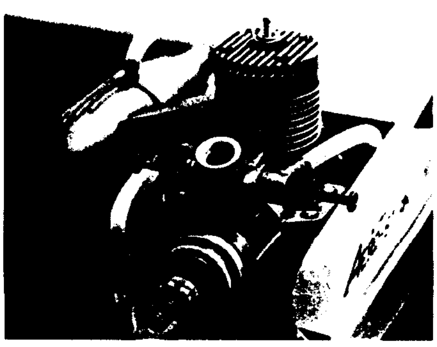


Fig. 2-12. Two-stroke glow engines like this one are simple, cheap, powerful, and easy to operate.

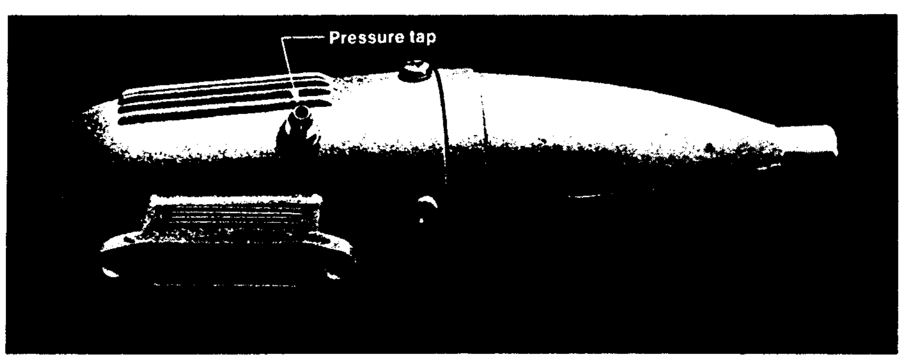


Fig. 2-13. The nipple on this muffler is a pressure tap. When you extend a line from the tap to the fuel tank, fuel is forced to the carburetor, dramatically improving engine reliability.

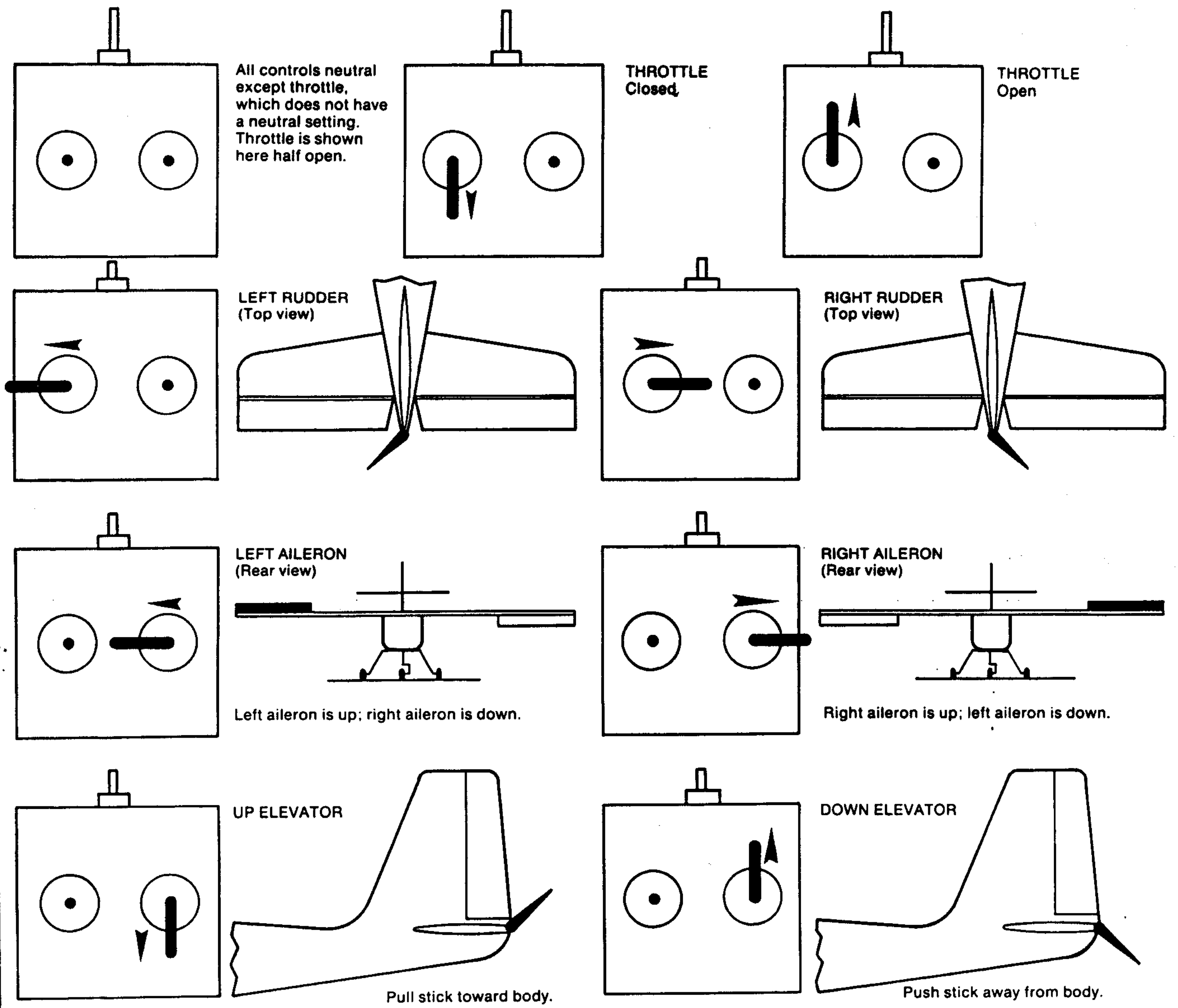
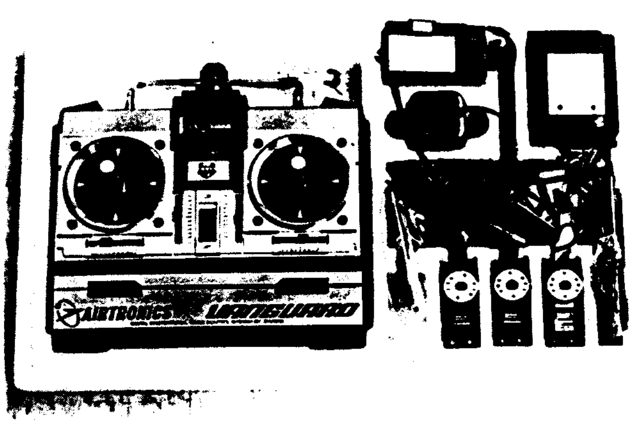
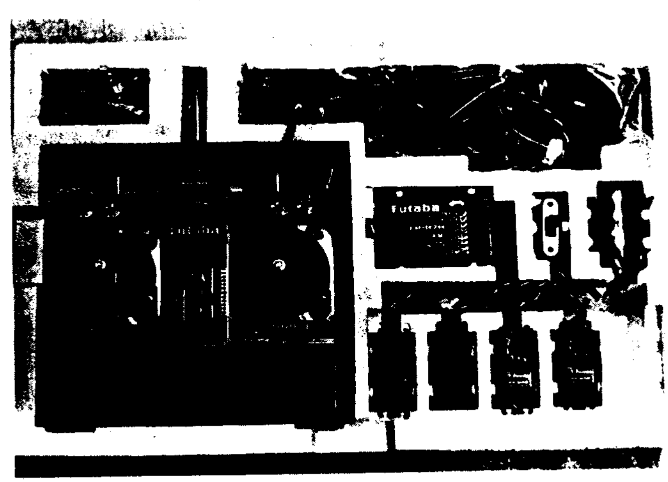


FIG. 2-15 MODE 2 TRANSMITTER CONTROLS

This is how the control functions are arranged on almost all U. S. transmitters. Unless your instructor uses another arrangement, buy a transmitter with this configuration.





Figs. 2-16 and 2-17. Both of these radio systems work well, but notice that one of them provides only three servos.

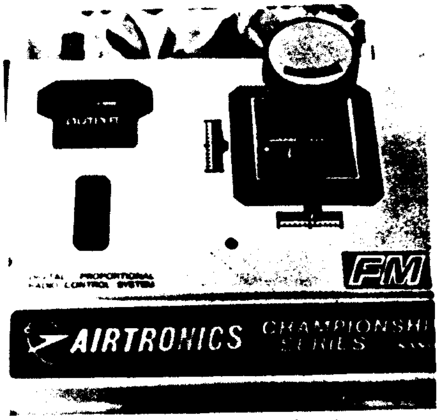


Fig. 2-14. For your first plane you're better off with transmitters that use sticks.

2) Frequency choice: Before buying a radio system, contact the club you'll be flying with. Some clubs keep track of who flies on what frequency and steer newcomers to less-crowded channels. Club members also know which channels are subject to local interference, and whether the club prohibits any legal frequencies at its field. The clerk at the hobby store may or may not be aware of all restrictions, but the club people will know.

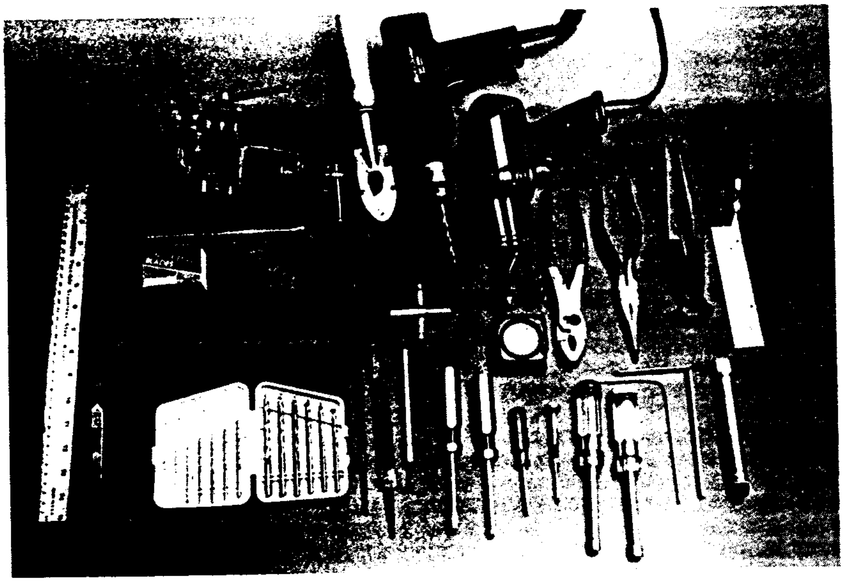
Unless you're a licensed amateur radio operator, you're restricted to 22 "aircraft only" frequencies on the 72-MHz band. For convenience, legal frequencies are designated by even channel numbers 12 through 56 (with channel 36 not used). These channels are separated by 40 KHz. In January 1991 the odd-numbered channels 11 through 59 will become legal, reducing channel separation to 20 KHz and requiring the more selective "1991" receivers and narrow-band "1991" transmitters.

Do not buy: 27-MHz equipment, it's subject to horrendous interference; 49-MHz equipment, it gives insufficient range; or any equipment on the "surface only" 75-MHz frequencies, it's both illegal and dangerous to use in aircraft.

3) At least four channels: The channels I'm talking about here are not the frequency channels mentioned earlier, but the control channels on the transmitter and receiver. Each channel is responsible for operating one servo, and you'll need four of them: one each for the elevator, rudder, throttle, and ailerons. It's possible to fly some planes on fewer channels, but you'll need four for your trainer and at least four for most other planes. Four is the minimum, but more won't hurt.

4) Two joysticks: Some transmitters have a wheel instead of the joysticks (see Fig. 2-14). That's fine if your instructor is comfortable with it, but useless if he isn't. Most people use joysticks, so you should start out that way.

5) Mode 2 stick configuration: Most U. S. RC pilots fly Mode 2, so unless



These tools and a few more will get that plane built.

TABLE 2: TOOLS REQUIRED

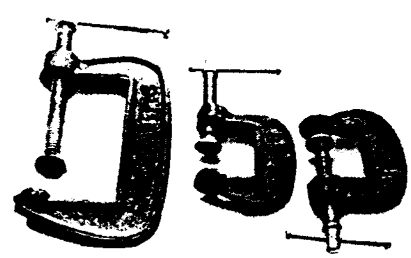
- ☐ *Pliers,* needlenose
- ☐ *Pliers,* standard
- ☐ *Pliers,* Z-bender

- ☐ *Prop wrench*
- ☐ *Modeling knife,* small
- ☐ *Razor blades,* single edge (25)
- ☐ *T-pins,* medium or small (100)
- ☐ *Soldering iron,* pistol grip
- ☐ *File,* flat
- ☐ *Sealing iron* (you can use a small flatiron, but it's not as good. If your plane is an ARF, it's already covered when you get it, but you'll need an iron to take out wrinkles and to make repairs).
- ☐ *Vise,* metal-working (you can use this kind of vise for wood if you place scrap plywood between the jaws and the wood you're working with).
- ☐ *Tape measure,* steel, six foot
- ☐ *Paintbrush* (1/4" or 3/8"). This item is optional. If you fuelproof exposed wood with super glue or epoxy, you can get by without it, but your plane will look better if you paint bare wood.
- ☐ *Goldberg scriber* (not absolutely necessary, but worth getting. If you're building a Goldberg kit, you already have one).
- ☐ *Drill,* electric, capable of accepting 5/16" bit
- ☐ *Drill bits,* set of 13 ranging from 1/16" to 1/4". For some planes you'll also need a 5/16" bit. Buy top-quality drill bits, not cheap ones.
- ☐ *Drill bit,* long, 1/8" diameter, 6" length.

Available in hardware stores and some hobby shops.

- ☐ *Screwdriver,* small
- ☐ *Screwdriver,* medium
- ☐ *Phillips head,* small
- ☐ *Phillips head,* medium
- ☐ *Straightedge,* 18"
- ☐ *Straightedge,* 48"
- ☐ *Drafting triangle or carpenter's square*
- ☐ *Coping saw or jigsaw*
- ☐ *Razor saw*
- ☐ *Penlight* (not a necessity, but handy for working in small, dark areas).
- ☐ *Ruler* (you can use the 18" straightedge if it's graduated in inches).
- ☐ *Hex wrench set,* containing sizes 0.05", 1/16", 5/64", and 3/32". These wrenches should be L shaped, rather than straight, to fit into confined places.

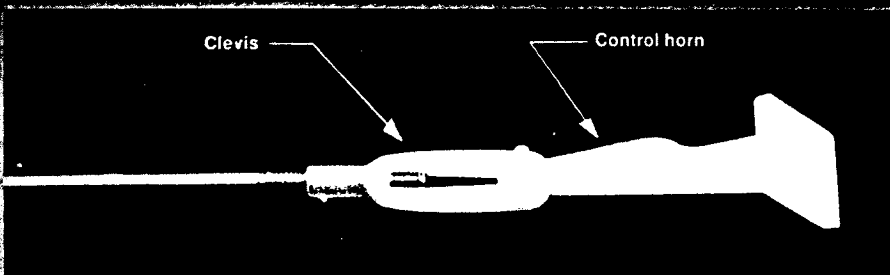
- ☐ *Sewing needle* (or very fine pin)
- ☐ *C-clamps,* 1" (4)



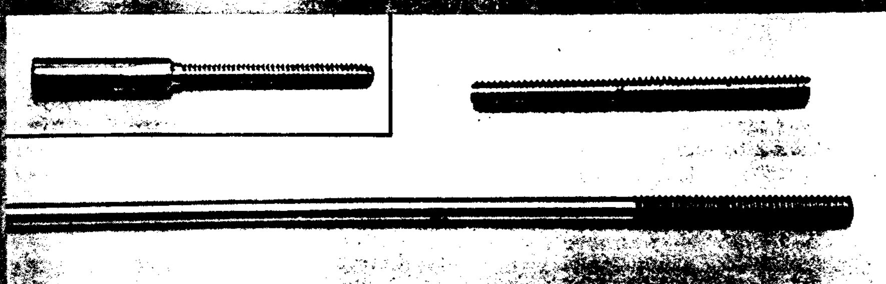
- ☐ *C-clamps,* 2½" (2)
- ☐ *Scissors*
- ☐ *Fine-tip felt marking pen*
- ☐ *Fox prop reamer* (you can survive without one of these, but it's handy).

The wood propeller combines efficient operation with safety and good looks.

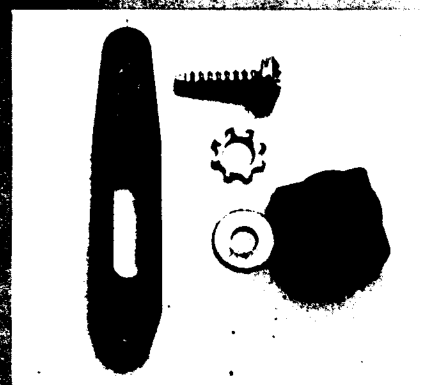
The glass-filled nylon propeller shown here is more crash-resistant than a wood one. It should be sanded before you use it to remove sharp flashing and the tips should be painted white or yellow so you can see the prop when the engine's running.



The clevis is the part screwed onto the metal pushrod. It connects the pushrod to the control horn which is then attached to the control surface.



A threaded coupler connects the throttle cable to the throttle clevis (left). Threaded pushrods (right): Most models use only the partly threaded rods, but if your model uses Gold-N-Rods you'll also use short, fully threaded rods like the one shown here. Don't rush to buy them. They come in the Gold-N-Rod package.



Adjustable servo arm: This device simplifies throttle setup. The large arm can be adjusted to whatever length you need to provide just the right amount of throttle travel.

TABLE 3: HARDWARE REQUIRED

☐ *Wheel collars* (7); six of these are used to hold the wheels in place. The seventh serves as a steering-arm bearing. Most kits provide some of these, but not enough. Count them and buy the difference. See the chapter on your plane for the correct size. NOTE: The Royal 20T requires only five collars.

☐ *Propellers* (six if you use wood, two if you use glass-filled nylon. I don't recommend pure nylon props. See the chapter on your plane for the correct size.)

☐ *Fuel line* (two feet); use silicone tubing. Make sure it fits tightly over the nipple on your engine's carburetor. When in doubt, use the next smaller size.

☐ *Clevises* (5); nylon. If your kit supplies metal clevises, replace them with nylon. Some kits provide plastic or nylon clevises of their own design. Go ahead and use them.

☐ *Steel braided cable in nylon sheath* (48"). DuBro sells a 48" Flex Cable Assembly, which includes a threaded coupler. If you buy this item, you don't need the threaded coupler listed next. The package also contains a metal solder clevis. Throw it out.

☐ *Threaded coupler* (1), short

☐ *Spinner* (1); plastic snap-on spinners are best. See the chapter on your plane for the correct size.

☐ *Cyanoacrylate hinges* (1 package) (Referred to elsewhere as CA hinges). Pro hinges from Radio South are excellent, as are Easy Hinges from Sig Manufacturing. These hinges replace any supplied in your kit. If your hobby dealer doesn't stock CA hinges, write to the manufacturer.)

☐ *Metal pushrods*; these should contain about an inch of 2-56 thread on one end. They're used to make pushrods for the elevator, rudder, and ailerons. They are not suitable for steering or throttle pushrods, which should be braided cable. See the chapter on your kit for the number needed, then count the number provided in your kit and buy the difference. (ARF models supply finished pushrods. Throw them out and make your own.)

☐ *Sullivan Gold-N-Rods* (semi-flexible set); most planes don't need these. Check the chapter on your kit. If you need them, be sure to get the semi-flexible kind. There are other grades you don't want.

☐ *Nylon adjustable servo arm*; available for most servos at your hobby shop or from Rocket City Specialties, Inc. If you use an Ace radio system, it probably comes with an adjustable arm. If not, you may be able to buy one from Ace.

☐ *Fuel tank* (1); if your kit doesn't contain a fuel tank, see the chapter on your plane for the correct size.

☐ *Wheels* (3); I suggest Dave Brown Lite Flite Wheels. The foam rubber wheels supplied with ARF kits are usually too small. You can make do with ordinary rubber wheels, but the foam ones will save you at least a couple of ounces, which is significant. See the chapter on your plane for the correct sizes.

☐ *Machine screws, washers, locknuts, and blind nuts*; quantities and sizes vary from one kit to the next. See the "Fire Wall Hardware" section of the chapter on your plane for sizes and quantities. Check the kit to see what you already have, then purchase the difference.

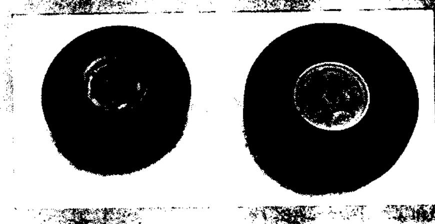
☐ *Pushrod connectors* (3) — also called EZ connectors.

MATERIALS REQUIRED

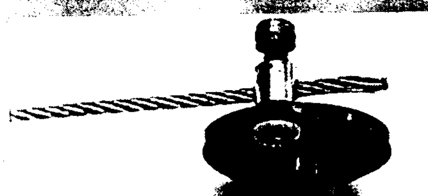
☐ *Cyanoacrylate (CA) glue*; thin, fast setting (2 ounces). Sold under various brand names (Zap, Jet, Hot Stuff, etc.). NOTE: Conventional CA glues produce irritating fumes. In early 1989 Satellite City marketed CA glues that don't produce these fumes. These products reached the market after I'd completed the planes for this book, so I don't know how they stand up in use. They seemed to work well on pieces of balsa and plywood in the shop and presumably will do fine on planes in the air. However, the thin version of this new user-friendly odorless "Hot Stuff" doesn't work as well on CA hinges as the fuming glues like Instant Jet. For the hinges you need the nasty stuff, but for everything else, you're probably okay with the new product.

You'll also need five-minute and thirty-minute epoxy.

Some of the materials you'll need (right).



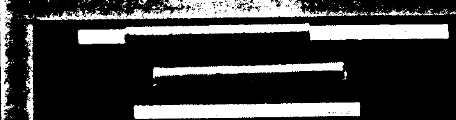
The larger wheel shown here is a Dave Brown Lite Flite wheel. It weighs much less than the smaller rubber wheel at its side.



You'll need thin and thick cyanoacrylate glues (CA) and an accelerator to speed their cure rates.

The pushrod connector attached to this servo wheel is used to hold a pushrod cable in place.

Silicone rubber glue: I keep finding new uses for this stuff. White is shown here, but use clear.



These are short segments of Gold-N-Rod. The outer tubing guides and supports the inner rod, which transmits control forces between servo and control surface. They are used where a curved pushrod path or a tight fit precludes the use of wood pushrods.

☐ *Cyanoacrylate (CA) glue;* thick, slow setting (4 ounces). Sold under various brand names (Slow Jet, Super T, etc., and the new user-friendly, odorless "Hot Stuff," which is non-irritating).
☐ *Accelerator for CA glues* (4 ounces); also sold under various brand names, all of which, as far as I know, work on all CA glues.
☐ *5-minute epoxy glue* (9 ounces)
☐ *30-minute epoxy glue* (9 ounces); some people are sensitive to epoxy glues. If I let it sit on me too long, I get itchy skin and blisters (especially annoying if I inadvertently rub my eyes and get blistered eyelids). I solved the problem by minimizing contact and by cleaning my hands almost immediately with a tissue soaked in alcohol, followed by a thorough washing with soap.
☐ *Balsa sheet* (1) ¼" x 3" x 36", medium or soft grade
☐ *Balsa sheet* (1) ³⁄₃₂" x 3" x 36", medium grade
☐ *Balsa sticks;* if you're building a .25 engine or smaller plane, you need two sticks ¼" square by 36" long, medium or hard balsa. If you're building a larger plane, you need two sticks ⁵⁄₁₆" square by 36" long.
☐ *Acid-core solder* (1 small roll); use the thin kind. Thick solder is hard to melt.
☐ *Silicone rubber glue* (3 ounces); comes in several colors. Most people prefer clear.
☐ *Seating tape* (1 roll); also sold as mounting tape. This tape is used between the wing saddle and the wing and should be about ¼" wide. If you end up with wider tape, you can trim it to fit the saddle.
☐ *Sandpaper, coarse,* 60 grit (1 sheet)
☐ *Sandpaper, fine,* 150 grit (1 sheet). If you're a stickler for a pretty finish, you can use finer paper after the 150 grit, but it isn't necessary.
☐ *Heat-shrink covering film* (2 rolls for .25 engine and smaller planes, 3 rolls for larger ones) — not needed for ARF models. I recommend Coverite's Black Baron films because they're easier to work with than most and because they are available in attractive colors. Pactra Solarfilm is also easy to apply. CAUTION: Don't buy any covering material before reading Chapter Five (Covering the Model).
☐ *Polyurethane paint, colored* (2 ounces). You can get by without this if you fuelproof exposed wood with CA glue or epoxy, but the model will look better if you paint those parts with a color that matches or complements your color scheme.
☐ *Polyurethane paint, clear* (2 ounces). You'll only need clear paint if your model uses stick-on decals. If you must soak the decals in water, they are already fuelproof, so forget the clear polyurethane.
☐ *Epoxy mixing cups* (36); I use wax-free paper cups which cost almost nothing at the grocery store. You can also hold paint in them, but not raw thinner. I avoid waxed paper cups on the theory that some wax may dissolve in the epoxy and weaken glue joints.
☐ *Cellophane tape* (1 roll), Scotch, etc.
☐ *Masking tape* (1 roll)
☐ *Duct tape* (1 roll)
☐ *Thinner for polyurethane paint* (4 ounces)
☐ *Petroleum jelly* (4 dabs)
☐ *Foam rubber* (1 sheet) ½" x 6" x 12"
☐ *Plywood sheet* (1) ⅛" by about 8" x 12"
☐ *Hardwood dowel* (1), either ¼" or ⅜" diameter and 3' long. Dowels should be the same diameter as the wing hold-down dowels supplied in your kit.
☐ *Waxed paper* (1 box)
☐ *Plastic sandwich bags* (6)
☐ *Rubbing alcohol* (16 ounces). Buy the cheapest clear (not colored) kind available and don't worry whether it's isopropyl or denatured ethyl; both work.
☐ *Facial tissues* (1 box)
☐ *Rubber bands* (¼ pound) No. 64
☐ *Balance weights;* don't buy these until you see if you need any. Stick-on weights are available at the hobby shop, or you can improvise. I often epoxy a few quarters to a plane to balance it.
☐ *Thread* (1 spool); almost any good cotton thread will do. If your plane uses Gold-N-Rods, you don't need thread.
☐ *Matte boards* (2); obtain a couple of 16" x 20" matte boards from the photo store. They're handy as cutting boards for covering film.
☐ *Velcro strip* (1" x 24"); optional, but is handy for anchoring the receiver and battery to the fuselage.

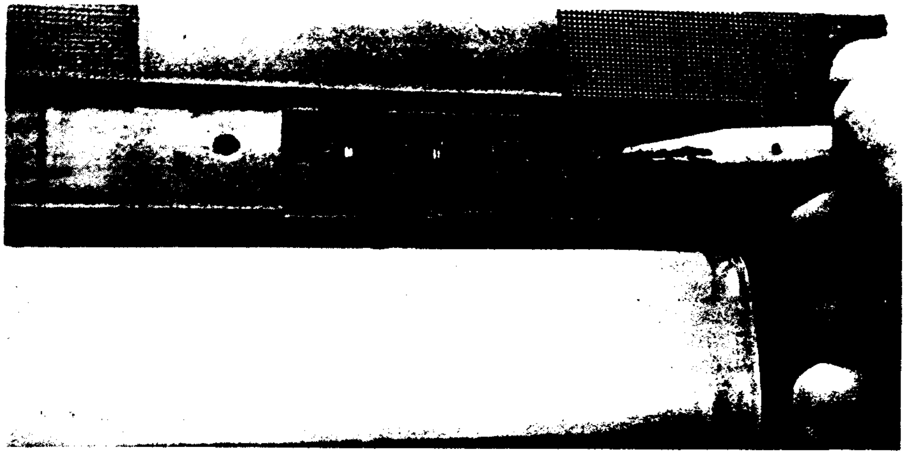


Fig. 2-18. Each of the small switches inside the back cover of this transmitter controls the direction of rotation of one servo. If you install the rudder servo and discover that it goes left when you give it right, simply flip the rudder servo reversing switch and all will be well.

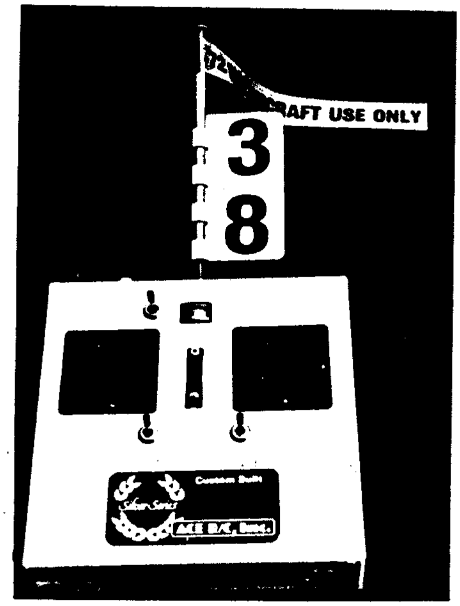


Fig. 2-19. The toggle switches on this transmitter are dual-rate switches for rudder, aileron, and elevator. They allow you to change the responsiveness of each control electronically in flight. For the expert that allows smoother aerobatic performance. The novice can use them to dial in aileron control throw changes without taking the wing off the plane. The only caution is this: Even on low rate, you need enough throw to fly the plane at low speeds, where controls are less effective.

your instructor is the exception, that's what you need to buy (see Fig. 2-15). It's also what your dealer is most likely to offer, but check to make sure.

6) At least four servos: Manufacturers often sell four-channel systems with only two or three servos (see Figs. 2-16 and 2-17). That makes for a low apparent price, but you need all four servos to fly. If you have to buy "extras" to get four, get the same kind that came with your set.

7) Nicad batteries: Just about every system now on the market comes with rechargeable nickel/cadmium batteries, but a few still come with old-fashioned dry cells. Nicads cost more, but you can recharge them hundreds of times and each time you go to the field you'll know you're starting with a full charge. Conventional batteries need to be replaced frequently, but since you have no way of knowing when they're low, you stand a good chance of crashing because of battery failure. Even if the conventional cells never fail you, the cost of replacing them will drive you to the poorhouse. Buy the Nicads.

8) Servo-reversing switches: Almost all transmitters come with servo-reversing switches; make sure yours does. They allow you to install the servo without worrying whether it turns clockwise or counterclockwise (see Fig. 2-18). One important warning: If you ever fly more than one plane from a particular transmitter, don't forget to check the controls before take-off. If you get airborne with reversed elevator or aileron controls, you will crash — period — even if you immediately recognize the problem.

9) Buddy cord: On some radio systems it's possible to connect a student's transmitter to an instructor's transmitter by cable, allowing the instructor to take control simply by lifting one finger from a switch. This saves the second or two normally required for the student to hand the transmitter to the instructor when he gets into trouble. That's a big advantage because in one second, a diving, out-of-control model can cover more than a hundred feet — down. I've been an RC flight instructor for many years, and I guarantee you there's no better learning aid than the old buddy box.

If you know an instructor whose transmitter can be hooked to a buddy cord, buy equipment compatible with his. If you can't do that, it might be worthwhile to buy a pair of transmitters that will accept the buddy cord. I feel that strongly about it, and I know at least two novices who successfully followed that route. The second transmitter is expensive (you'll probably have to buy the whole radio system), but it won't cost as much as the plane you may destroy without it, and it will do wonders for your nerves when you begin to make landing approaches.

10) Modulation: There are now three kinds of modulation in common RC use: Amplitude Modulation (AM), Frequency Modulation (FM), and Pulse Code Modulation (PCM). At our field FM receivers are sometimes picking up interference from AM transmitters, so you're safer at our field with an AM system. As 1991-certified equipment takes over and the old wide-band transmitters are phased out, however, this should change. The industry seems to be shifting to FM and PCM. PCM is more interference-resistant than FM, but also more expensive. The situation is changing too fast for me to give any advice that won't be wrong by the time you read it. Your best bet is to visit the club flying field and find out what's working well there before you buy anything. Talk to a number of people.

11) Dual-rate switches: These will allow you to adjust your control throws electronically (see Fig. 2-19).

That covers the big purchases, but you'll also need the tools, hardware, and building materials in the tables on pages 9-11 (on ARF kits you can skip the covering material). There may also be a short list in the chapter on your plane covering items specific to that plane. Check off what you already have, then buy the rest. Table 2 lists the tools you'll need.

Table 3 lists the hardware and materials you'll need. It covers only items that aren't supplied with every kit included in THE BOOK. Your kit may contain some of these items, so prepare an inventory before you buy. In certain cases the items listed here are intended to replace items that are included with your kit or radio system. For instance, braided cables replace the solid steering and throttle pushrods supplied with most kits, CA hinges replace kit hinges, nylon clevises replace metal ones, and the adjustable servo arm replaces the fixed arm or wheel that comes with your throttle servo.

And that's it. Now you can turn to the next chapter and start building.


Fig. 3-1. A small area like this in your house or garage is all the room you'll need to work on your plane.

3. Miscellaneous preliminaries

Now that you've assembled the materials listed in the last chapter, you're ready to begin building the plane — almost. There are a few other matters you'll need to consider before you actually start building.

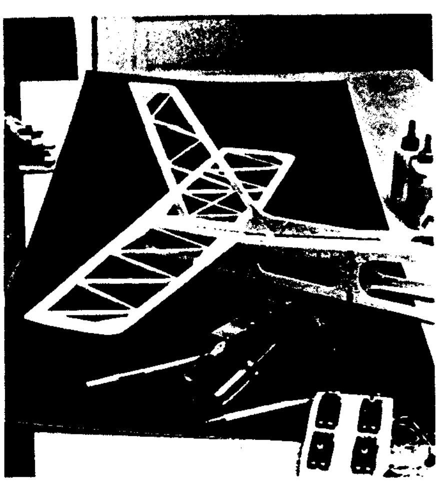


Fig. 3-2. The building surface can be anything really flat that you can stick pins into. It doesn't have to be fancy, just absolutely flat.

THE BUILDING AREA

It's nice to have a big workshop with every possible tool, but it isn't necessary. The main requirements are an out-of-the-way work area where you can leave your partially built model undisturbed between working sessions and a flat working surface (see Fig. 3-1). You'll also need decent overhead lighting. A small exhaust fan to carry glue fumes out of the house won't hurt, either.

I use a big, inexpensive plywood door I bought at a lumberyard for the working surface (see Fig. 3-2). Other people build on cork bulletin boards, or just put Celotex or a similar material over a flat tabletop.

HOMEMADE TOOLS

Some tools are not readily available from hobby shops or are just easier and less expensive to make yourself.

Sanding Tools

If you're building a conventional kit, you'll need a few sanding blocks (see


Fig. 3-3. Sanding tools like these will do the job.

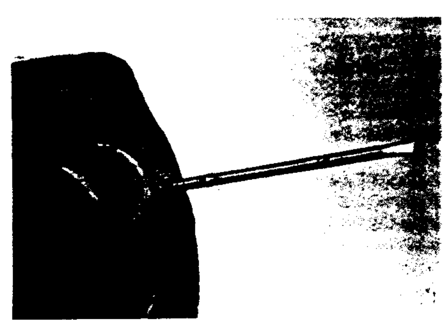


Fig. 3-4. Make your reaming tool by filing one end of pushrod wire to a blade.

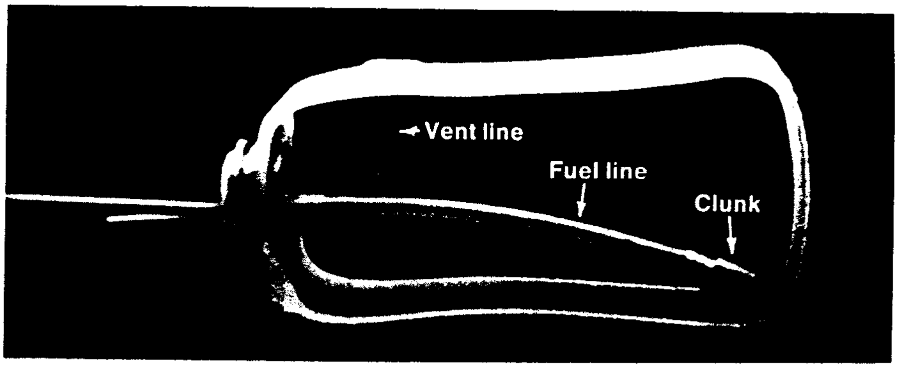
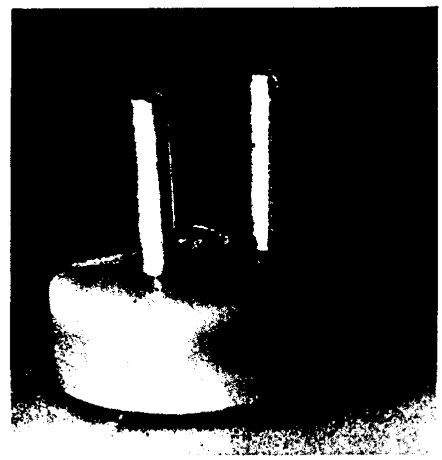


Fig. 3-5. I cut this fuel tank apart to demonstrate properly arranged fuel and vent lines. The weighted end (the clunk) of the fuel line is free to move and the vent line extends into the molded bubble at the top of the tank.



Figs. 3-6 and 3-7. Saw the metal lines, then file them smooth. If you leave a jagged edge, it will eventually cut the silicone fuel tubing that fits over the lines and cause all sorts of engine problems.

Fig. 3-3). I make these from 1/4" balsa sheet with coarse sandpaper on one side and fine paper on the other. Glue the sandpaper in place with CA glue. It may look messy, but it works. For starters, make two blocks, one 3" x 12" and the other 2" x 4". Later you can make special sanding tools as needed. For instance, sandpaper glued around a 1/4" hardwood dowel often comes in handy.

Reaming Tool

This is a 1/16" pushrod wire with a 90° bend at the threaded end and a filed blade at the other (see Fig. 3-4). Use it to ream servo arm holes and drill holes for elevator and rudder horn screws.

FUEL TANK ASSEMBLY

Assemble the fuel tank according to the manufacturer's instructions, but don't necessarily believe what they say about the length of the fuel line inside the tank. If the assembled tank is held vertical, the clunk should not touch the bottom at any point, no matter what the manufacturer says (see Fig. 3-5). There are also two other important things to keep in mind:

1) The stopper must be screwed firmly in place so it can't be pulled out; otherwise, the tank will leak. On the other hand, don't tighten it too much or you'll strip the nylon insert that holds it in place — and the tank will leak.

2) You'll have to cut the metal fuel lines if your tank has them and file them smooth, as shown in Figs. 3-6 and 3-7. Check the plans, if any, to see where to cut. If your plane is an ARF, you can check by fitting the tank into the plane itself.

With these preliminaries out of the way, you can finally start building (see Figs. 3-8, 3-9, and 3-10).

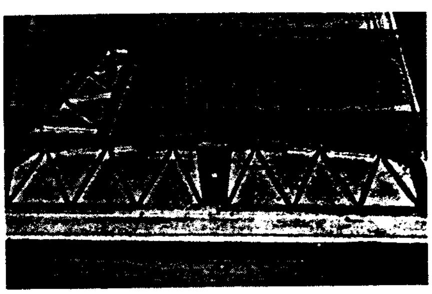


Fig. 3-8. To start, open the manual,

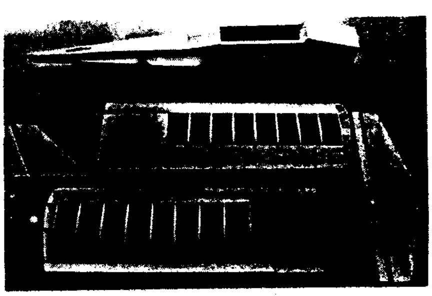


Fig. 3-9. lay the kit out on the bench,

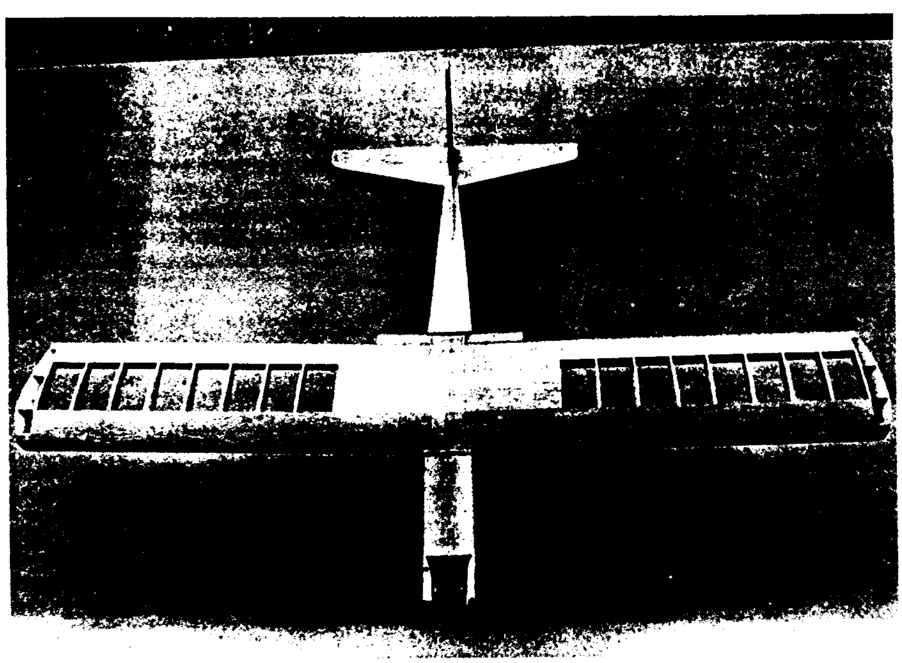
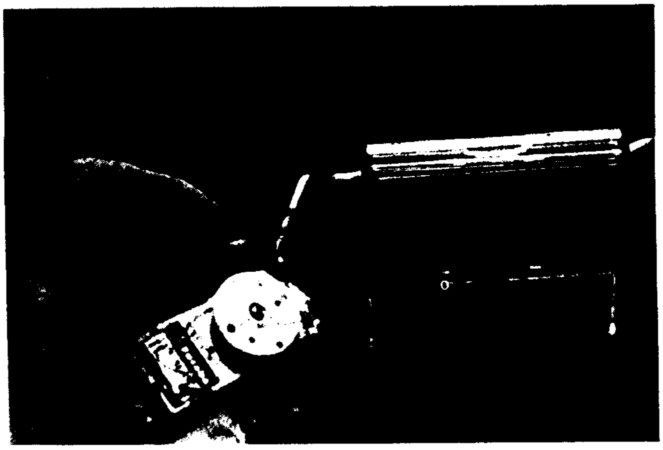
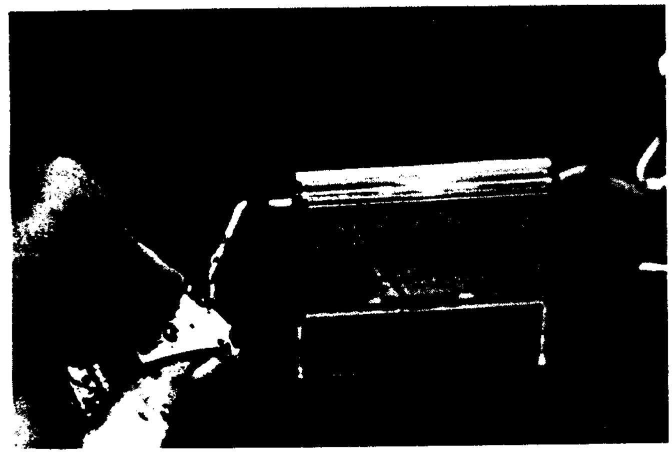


Fig. 3-10. and begin framing the model according to the instructions.





Figs. 4-1 and 4-2. I rigged this servo to an ammeter to show how installed controls drain a battery. You can't see the transmitter, but in both cases it's set for up elevator. The difference is that in one photo I'm holding the servo wheel to stall the servo. This causes the servo to draw enough current to drain the battery quickly — with disastrous results. Whatever else you do, install the servos so they can't stall in use.

4. Preliminary radio installation

THE MANUAL that comes with most kits tells you to install the radio system after everything else is completed, but the experienced modeler makes a temporary installation before covering the airplane, and if possible, before planking the top of the fuselage. It's easier that way, and if you make a mistake, there's no need to hack up your finished model to correct it. If you're building an ARF, your model is already covered, so you have to be more careful, but the procedures are much the same.

Your job is to install the radio system in such a way that: (1) the electronic items within it are protected from vibration; (2) all controls respond positively and exactly to transmitter commands with minimum battery drain; and (3) nothing comes apart or hangs up in use (see Figs. 4-1 and 4-2).

Along the way, you'll also install the engine mount, the engine, and the nose gear assembly. It will take at least several nights to do all this, and then you'll take everything apart again and it'll look like you accomplished nothing. Don't be upset. The payoff comes when you do an effortless final radio installation.

THE SYSTEM

The on-board control system consists of a receiver, a Nicad battery pack, four servos, a switch harness, a number of pushrods and control horns, and all the odds and ends that tie them together (see Fig. 4-3). In this chapter you'll temporarily install these components, except the switch harness and the aileron servo, which are best left for later. I will frequently refer to the transmitter as the Tx and the receiver as the Rx.

PRELIMINARIES

First, charge all batteries overnight. Next, hook up the Rx, battery, switch harness, and all four servos according to the radio manufacturer's instructions. Turn on the Rx and Tx and test the system. I once skipped this step and installed a radio that didn't work! When you're sure the system is okay, disconnect everything and lightly tape about half an inch of foam rubber around the Rx and battery as shown in Fig. 4-4.

CHOOSING A SERVO TRAY

If you're building an ARF, use the plywood servo tray provided in the kit. On conventional models you have more choices. Most radio sets come with a plastic servo tray, which is perfectly

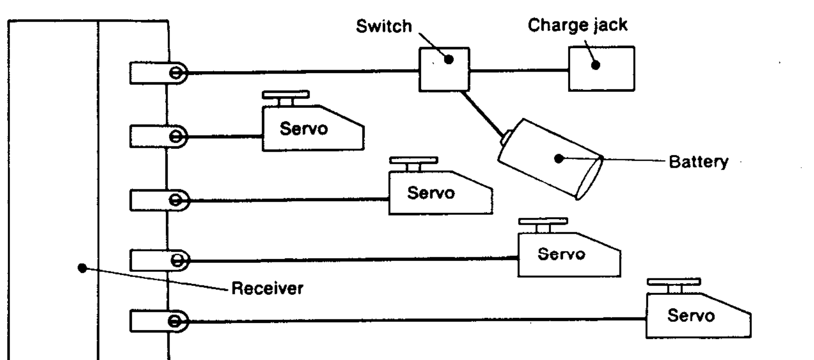
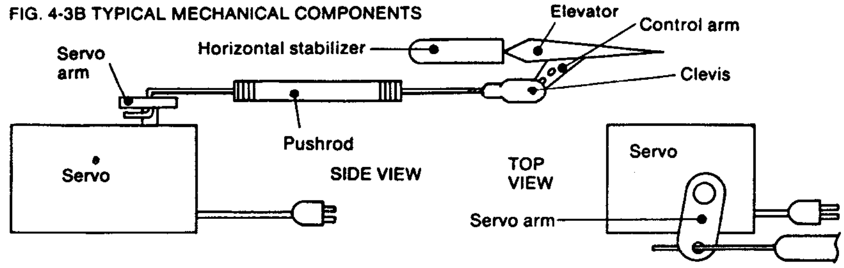


FIG. 4-3A THE ELECTRONIC COMPONENTS

FIG. 4-3B TYPICAL MECHANICAL COMPONENTS



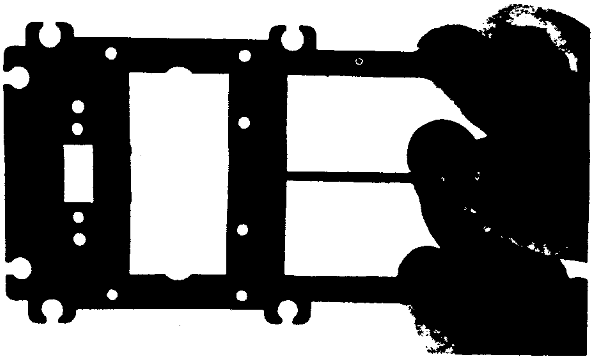


Fig. 4-5. Here's a plastic servo tray.

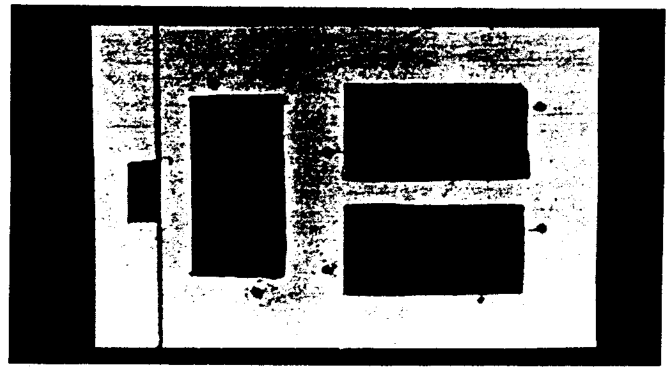


Fig. 4-6. This plywood servo tray will also do the job.

Fig 4-4. You cover the whole battery except the leads, and everything on the receiver except the antenna and the servo lead receptacle.

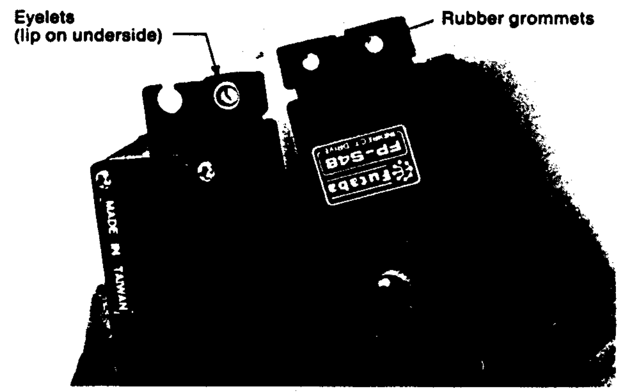


Fig. 4-7. Eyelets hold the rubber grommets in place. The lip on each eyelet goes on the underside of the grommet.

good provided it fits the geometry of your installation (see Fig. 4-5). Many kits provide plywood trays, which also work fine, or you can cut your own from ⅛" ply if necessary (see Fig. 4-6). Before you decide on a tray, check the radio drawing in the chapter on your plane.

BEGINNING INSTALLATION

Slip rubber grommets into the mounting lugs on each servo (and the plastic tray if you use it), then press a metal eyelet into each grommet to make sure that it is fastened tightly (see Fig. 4-7).

Now install the servos in the tray. If you use a plywood tray, mark and drill pilot holes for the servo hold-down screws as shown in Fig. 4-8, then screw the servos in place. Make sure they don't touch any wood (see Fig. 4-9).

Your next step is to remove the servos from the tray and begin installing the servo tray rails (if your plane uses them) and the tray itself. Check the chapter on your plane, and if there are no comments on installing servo rails or tray, follow THE MANUAL's instructions, keeping these points in mind:

1) Before gluing any rail or tray, test fit the tray, the battery, and the Rx to be sure there's space for everything and that the rails and tray can be properly positioned relative to one another. The servos must not touch the rails at any point and the battery lead and an-

Fig. 4-8. The pilot holes for the servo-mounting screws should be ¹⁄₁₆".

Fig. 4-9. The servos must clear the tray by at least ¹⁄₁₆" all around. If they directly touch wood, engine vibration could cause the servos to fail.

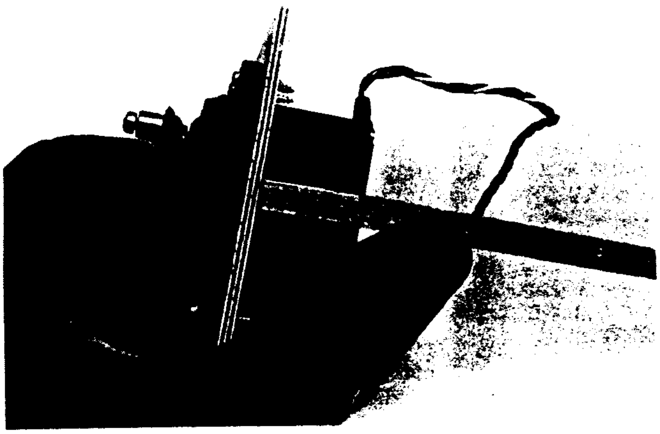


Fig. 4-10. Mark a balsa stick at the bottom of the servo and make a second mark ⅛" beyond the first.

Fig. 4-11. Measure to be sure the servo rail is higher than the second mark when the end of the stick touches the fuselage floor at its highest point.

tenna must not be mashed against anything hard.

2) Before gluing any rail or tray in place, measure to be sure the servos will clear the highest obstruction on the bottom of the fuselage by at least ⅛" (see Figs. 4-10 and 4-11). If they won't, place the tray higher.

3) If you use a plywood.tray, I suggest that for added security you epoxy it in place, rather than fastening it with wood screws. This makes installing servos less convenient, but I think it's a good trade off. If you use a plastic tray, you'll have to screw it to the rails as shown in Fig. 4-12.

4) Regardless of what THE MANUAL says about gluing the rails or tray, use epoxy, not CA. Epoxy seems to tolerate vibration better.

5) If the rails just butt against the fuselage sides without any bracing, add braces as shown in Fig. 4-13.

If you use a plywood tray, install the servos after the glue on the tray sets. If you use a plastic tray, install the servos, then screw the tray in place. Once the servos are in place, you can move to the front of the bird.

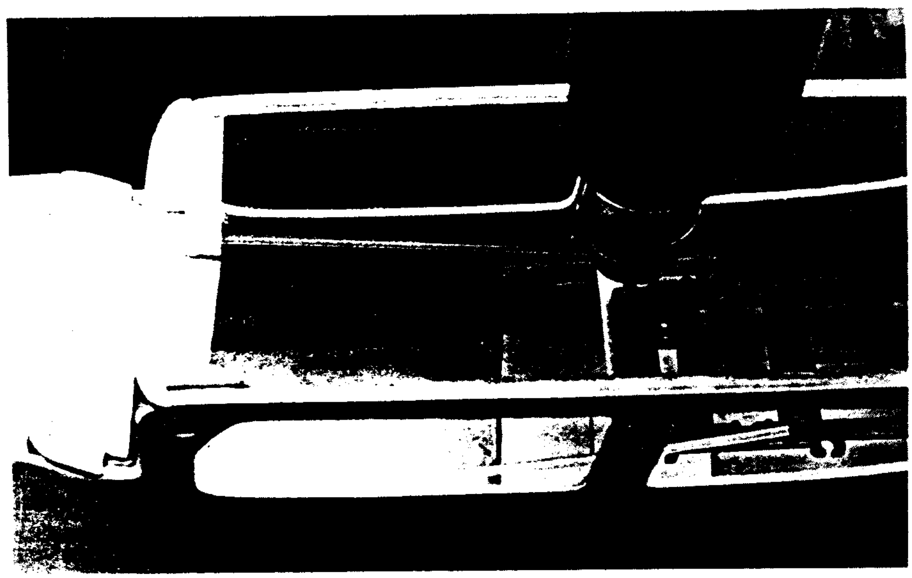


Fig. 4-12. If you're using a plastic tray, use it as a guide to drill the rail's mounting holes.

MOUNTING HARDWARE TO THE FIRE WALL

On all the models covered here, the nose gear bearing is bolted to the fire wall. In some cases, so is the engine mount. Follow THE MANUAL'S instructions for mounting them, with the following exceptions:

1) If your kit supplies ordinary hex nuts to hold anything to the fire wall, replace them with blind nuts — sometimes called T-nuts in a few MANUALS. (see Fig. 4-14).

2) If the fire wall for your kit has predrilled holes for the throttle and steering pushrods, plug them with five-minute epoxy (see Fig. 4-15). You'll drill new holes later. Don't plug any other pre-drilled holes.

3) Cut all mounting bolts flush with their blind nuts. Figures 4-16 and 4-17 show how.

ENGINE MOUNTING

Alignment: Engine alignment is critical. Most trainers have a little built-in right thrust. Make sure yours has the amount shown on the plans. Whatever you do, don't build in left thrust or your plane will be a monster on takeoffs.

If you end up with left thrust, do whatever it takes, including cutting a new breakaway plate, to get rid of it.

Mounting: The Royal-Air 20T and 40T contain special vise-like engine mounts that allow you to install the engine without drilling any holes. If you are building either of these planes, refer to THE MANUAL for mounting instructions as well as my discussion in the chapter on them. If you are building any of the other planes covered

Fig. 4-13. The support braces should be made from ¼" balsa

Fig. 4-14. Replace any hex nuts supplied in your kit with blind nuts.

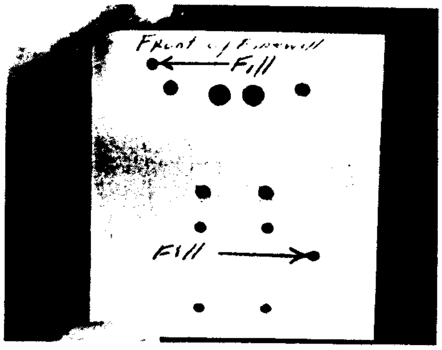


Fig. 4-15. Fill these holes in the fire wall with five-minute epoxy.

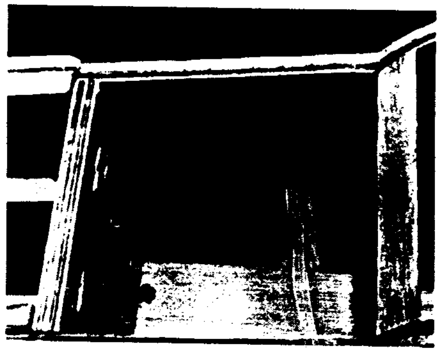


Fig. 4-16. These bolts could puncture the fuel tank.

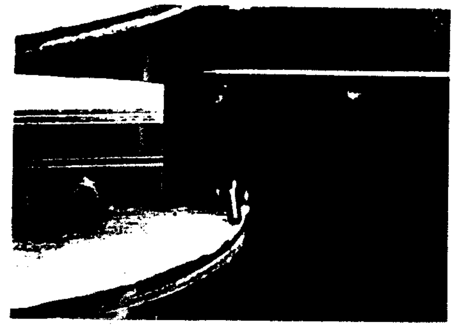
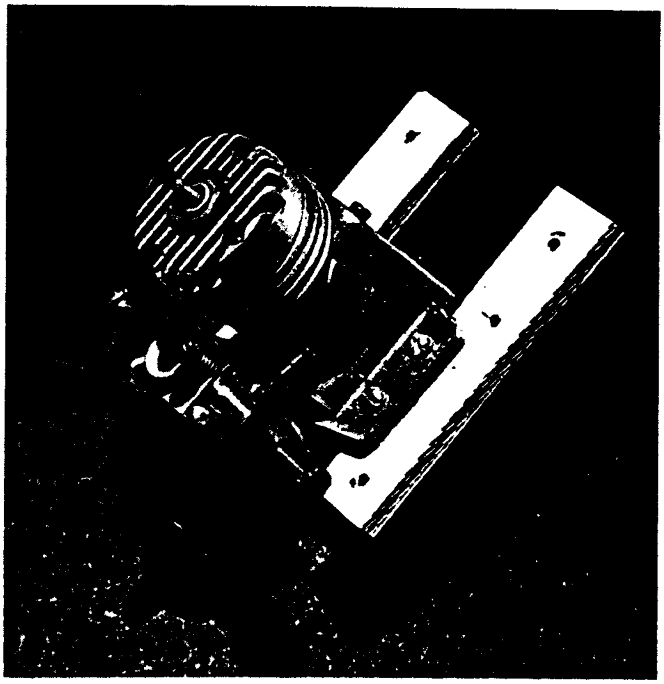


Fig. 4-17. Using a razor saw or similar tool, cut the bolts so they are flush with the blind nuts.



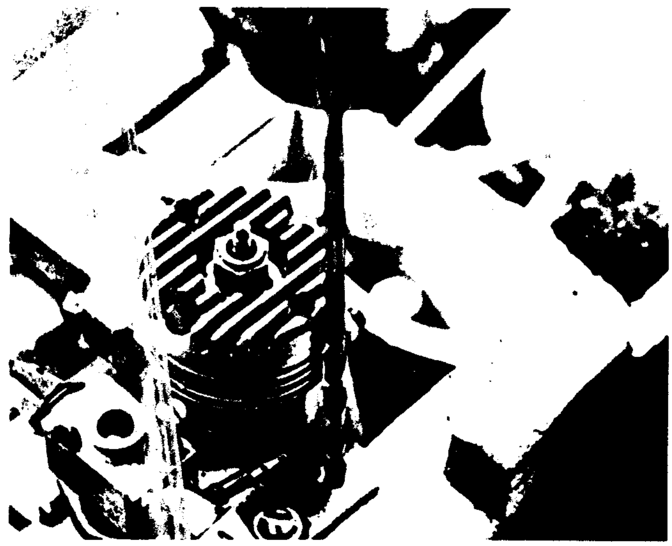


Fig. 4-18. Use your long ⅛" drill to drill bolt holes one at a time.

Fig. 4-19. An engine bolted to breakaway plates. The plates should be bolted, not screwed, to their bearers in the fuselage.

here, you'll have to drill bolt holes in the engine mount, which may be a black, glass-filled nylon mount or a wood breakaway plate. For the most part, the instructions in THE MANUAL are fine. If your engine mount is the glass-fiber type and you intend to tap it to take mounting bolts, follow the manufacturer's instructions only; however, if you're using a .40 or larger engine, tap it for 6-32 bolts, rather than 4-40s.

If you don't intend to tap your mount, here's how to proceed. Install the prop and spinner and position the engine so that the spinner backplate clears the front of the fuse or the plastic cowl by ⅛". If your plane has a plastic cowl see the instructions in THE MANUAL and in the chapter on your plane for locating the engine on its mount.

Tack glue the engine in position with a couple of drops of CA, then, as shown in Fig. 4-18, use a long ⅛" drill to make the first hole in the mount. Install the first mounting bolt, then drill the second hole, install the second bolt, and so on until you get all four bolts installed. This procedure guarantees that you won't drill any holes in the wrong place.

MOUNTING BREAKAWAY PLATES

(Skip this section if your plane has a glass-filled or metal mount.)

On some airplanes the engine is mounted on a breakaway plate and THE MANUAL tells you to attach the plate to the engine bearers with wood screws. Don't do it. Use 4-40 machine screws (bolts) with blind nuts, because wood screws are likely to pull out of the wood in time (see Fig. 4-19).

THROTTLE AND NOSE GEAR "PUSHRODS"

The pushrods that move the throttle and nose gear should not be rods at all, but braided cables that slide inside nylon tubes (see Fig. 4-20). Most kit manufacturers supply solid wires for this job, but since these can rub or hang up in the fuel tank compartment, I routinely throw them out and install cables. I'll describe that installation shortly.

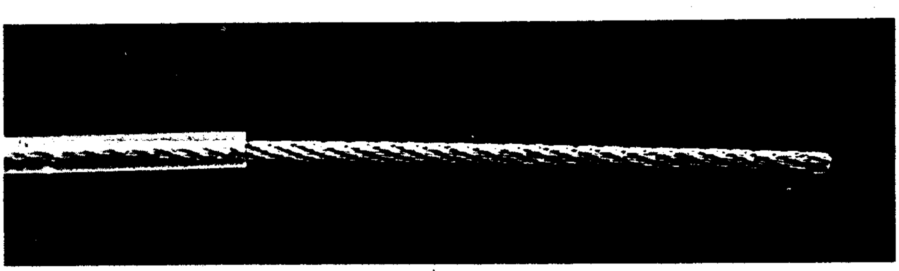


Fig. 4-20. Use cables inside nylon tubes like this instead of the solid wires supplied as throttle and steering pushrods.

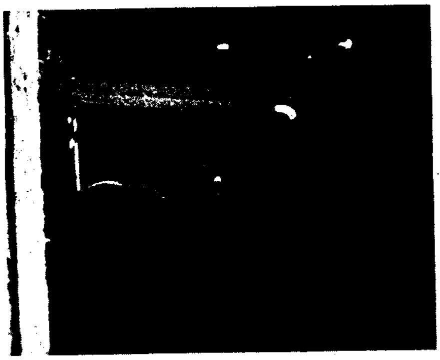


Fig. 4-23. Rotate the steering arm against the fire wall and insert a 1/16" drill bit through the connector hole. Tap the bit lightly to mark the fire wall. Then rotate the steering arm out of the way and, using your long 1/8" drill bit, drill through the fire wall at the mark.

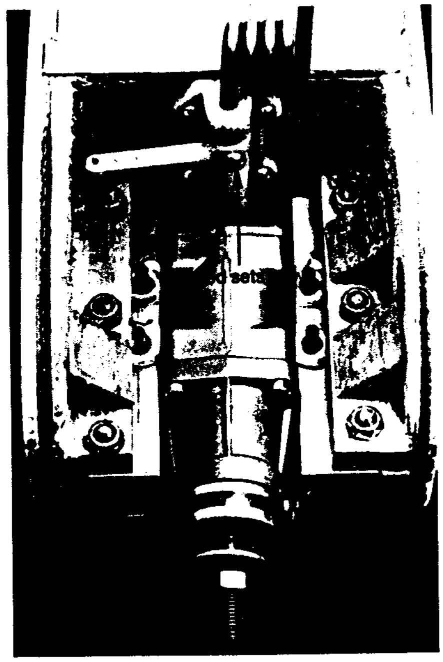


Fig. 4-21. The steering arm is held in position by a setscrew, which has a tendency to slip on occasion.

Fig. 4-22. To prevent this slippage, file a flat spot on the nose gear as shown here. Align the file with the steering arm.

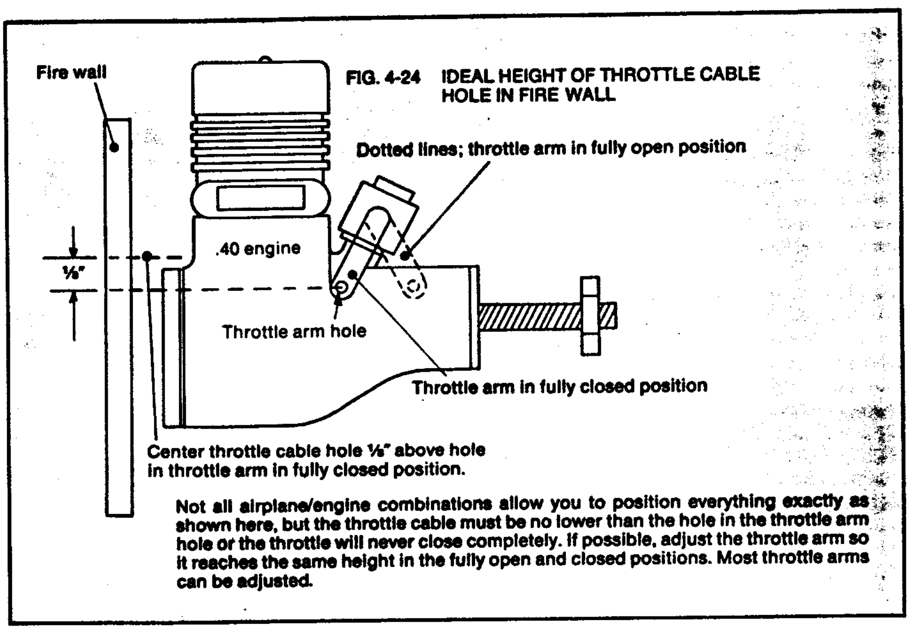


FIG. 4-24 IDEAL HEIGHT OF THROTTLE CABLE HOLE IN FIRE WALL

Not all airplane/engine combinations allow you to position everything exactly as shown here, but the throttle cable must be no lower than the hole in the throttle arm hole or the throttle will never close completely. If possible, adjust the throttle arm so it reaches the same height in the fully open and closed positions. Most throttle arms can be adjusted.

FILING THE NOSE GEAR STRUT

Before you can locate the hole for the nose gear steering arm cable, you have to install the nose gear strut and the steering arm. The steering arm is locked onto the strut with a setscrew that has trouble getting a good bite on the strut and tends to slip under pressure (see Fig. 4-21). After a landing or two, the plane no longer goes straight with the rudder stick in neutral but veers left or right.

To prevent the problem, file a flat spot on the strut where the setscrew will contact it (see Fig. 4-22). In a couple of kits, the flat spot is already filed. Don't make another one. The coil faces the rear of the plane and the steering arm makes an angle with the fire wall when the nose gear is in the neutral position.

LOCATING THE STEERING CABLE HOLE

Once you've filed the flat spot, install the strut through the bearing and steering arm, tighten the setscrew, and insert a pushrod connector in the outermost hole of the steering arm. Make sure the arm and connector are on the left side when the plane is right side up.

If you're building a Royal 20T, see the chapter on your plane for the location of the steering cable hole. Figure 4-23 shows where it is on other planes.

DRILLING THE THROTTLE CABLE HOLE

Now you need a hole for the throttle cable. Figures 4-24, 4-25, and 4-26 show you how to drill it. If you've removed the engine, re-install it with two bolts, then pull the throttle arm on the carburetor to the fully closed position. You may have to adjust the throttle stop setscrew (see Fig. 4-27). Next, line up your long 1/8" drill with the outermost throttle arm hole and drill a hole in the fire wall approximately 1/8" higher than the throttle arm hole with the throttle completely closed (see Fig. 4-25). Aim the drill in the general direction of the throttle servo arm inside the fuselage. Make the angle between the drill and the fire wall as close to 90° as possible, given that you have to miss the fuel tank. When you're satisfied with the position, drill the hole, then remove the engine.

CABLE TUBING INSTALLATION

Insert a length of nylon tubing from your cable set through the just-drilled throttle cable hole and guide it to the throttle servo. Use a razor blade to cut the tubing about 1/4" in front of the fire wall and 1 1/2" in front of the throttle servo arm. Repeat this operation for the steering cable tubing (see Fig. 4-28). (On the Royal 20T the steering cable exits the bottom of the fuselage, not the fire wall. Cut the tubing so that about 1/4" protrudes beneath the fuselage.) Now glue both the steering and throttle cable tubes to the fire wall (or fuse bottom) with thin CA.

Follow this with thick CA and accelerator and cut the tube flush with the fire wall or fuselage bottom.

FUELPROOFING THE TANK COMPARTMENT

If your plane has a removable fuel tank hatch cover, use thin CA glue to

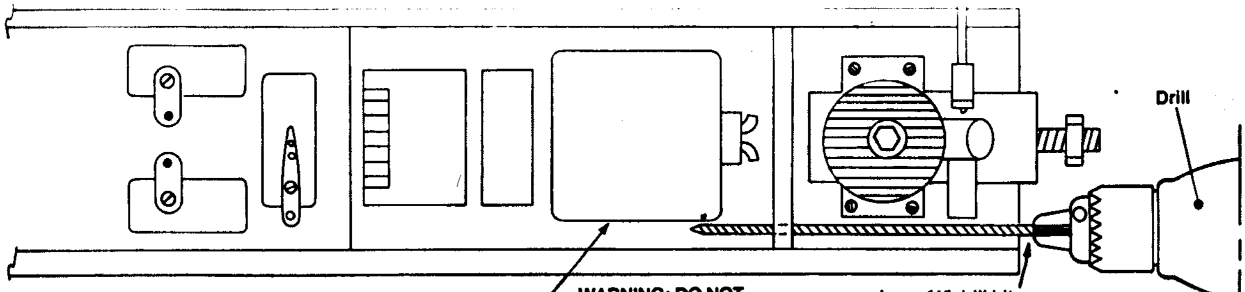


FIG. 4-25 DRILLING THE THROTTLE CABLE HOLE

Aim the drill from the engine's throttle arm to as close as you can get to the throttle servo arm. You won't be able to get a perfectly straight shot at the servo arm, so there will be some bend in the throttle cable as it snakes around the fuel tank. Keep the bend as gentle as possible.

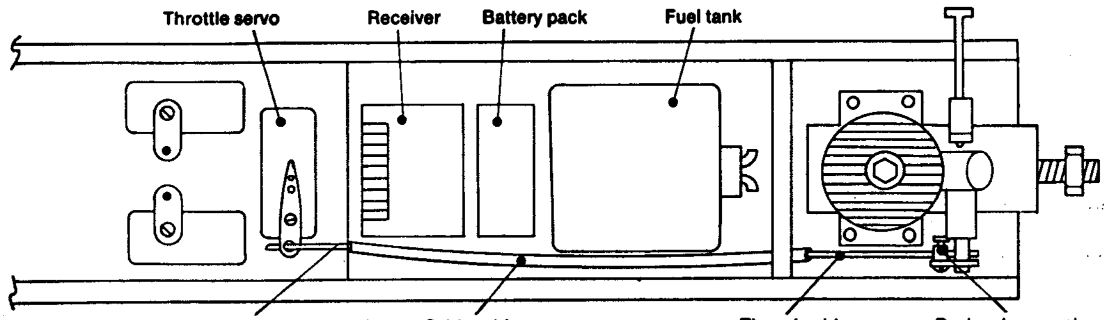


FIG. 4-26 PATH OF THE THROTTLE CABLE

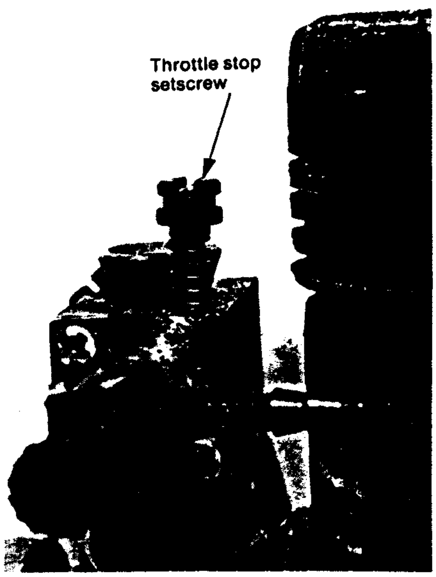


Fig. 4-27. The carburetor may not close completely, but it will after an adjustment to the throttle stop setscrew.

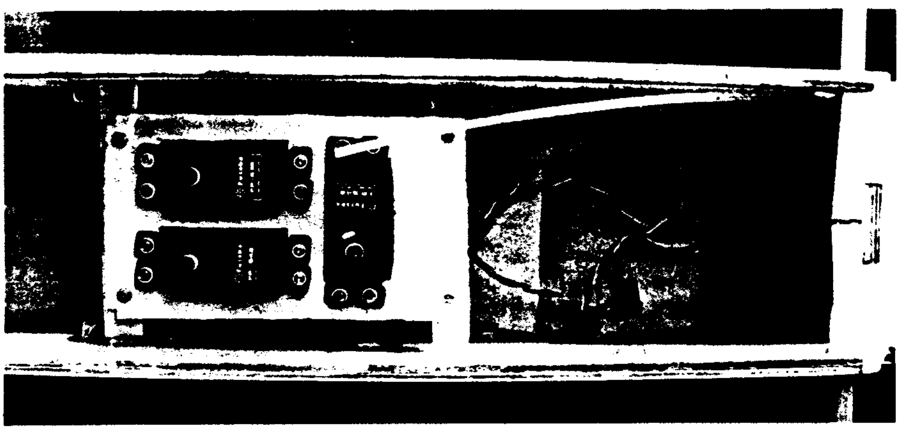


Fig. 4-28. Aim the rudder cable at the rudder servo so you'll know where to cut it.

fuelproof the inside of the cover, the rear of the fire wall, and the remainder of the wood inside the compartment (use a plastic bag to protect your hand). Then use silicone rubber glue to attach foam rubber to the rear of the fire wall (see Fig. 4-29).

On a few planes you can't get at the fuel tank compartment, so forget about fuelproofing it, but glue foam rubber to the front of the tank with silicone glue to protect the tank when you install it.

TEMPORARY FUEL TANK INSTALLATION

Pad the tank compartment and the tank as shown in Figs. 4-30 and 4-31. It

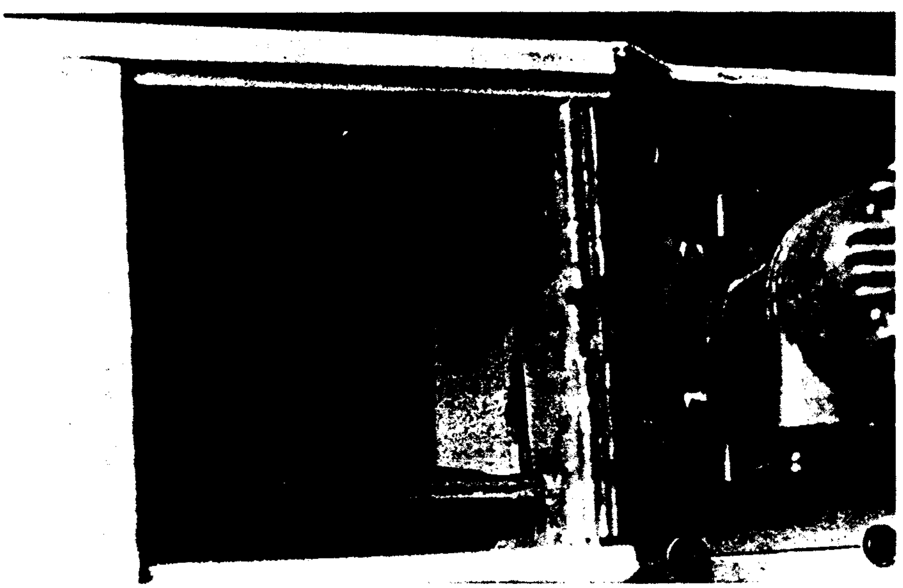


Fig. 4-29. Glue foam rubber to the rear of the fire wall to protect the fuel tank. It should cover all the blind nuts.

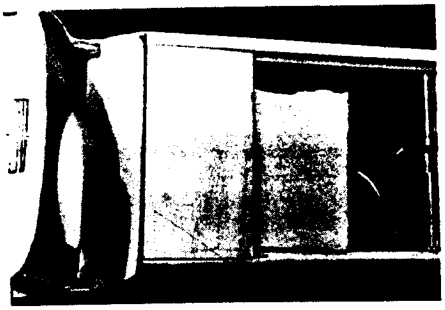


Fig. 4-30. Temporarily install and pad the tank.

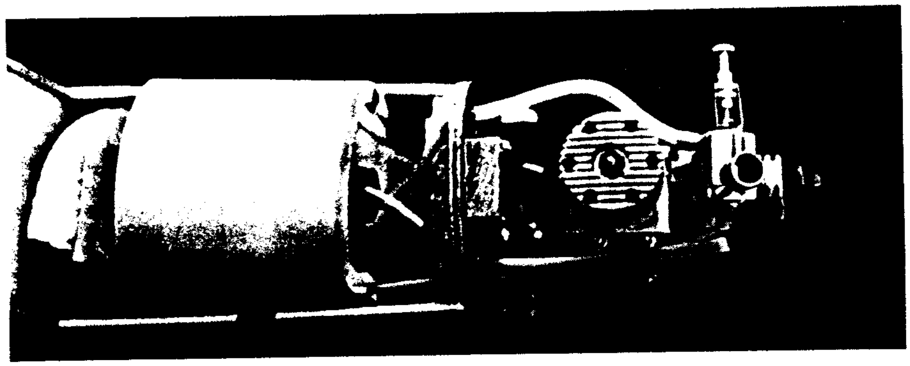


Fig. 4-31. Different planes require different approaches, but the idea is the same: The tank should touch only foam rubber.

doesn't matter exactly how you do it, but make sure the tank is protected from contact with everything except foam rubber when you install it. On most planes you can just slip the silicone fuel lines through the holes in the fire wall and connect them to the tank. If your plane has a plastic hatch cover, temporarily install it over the tank according to instructions in the chapter on your plane and THE MANUAL to be sure it fits, then remove it. If your plane does not have a tank compartment hatch, check THE MANUAL on how to install the tank. Otherwise, just shove it in place. On some planes you will have to trim the formers to make room for both tank and foam.

INSTALLING BRAIDED CABLES

Alter the throttle and steering tubings so they still lead to the proper servos with the tank in place. Now connect the battery and Rx to the switch harness and plug each servo lead into the appropriate receptacle in the Rx.

Cut with pliers two pieces of braided cable, one for the throttle, one for the steering. Each cable should be about five inches longer than the tube into which it will fit. Cut the wire cleanly because even a little fraying makes the following operations difficult.

You are about to solder some parts and I suggest you wear safety glasses because solder can spit at you. I also suggest, based on painful experience, that you not solder while barefoot.

Tin one end of each cable about 1½" back. To do this, place the cable in a vise as shown in Fig. 4-32. Hold a soldering iron against the bottom of the cable and a length of acid-core solder against the top. When the solder melts, it will flow into the wire braiding. Figures 4-33 and 4-34 show what to do next.

Now pre-solder a threaded coupler. Gently mount it in a vise, being careful not to damage the threads, and apply heat to the side while holding solder against the opening (see Fig. 4-35). The solder will melt and fill the hole.

Without removing the heat from the side of the coupler, shove the tinned throttle cable (make sure it's the throttle cable) into the hole and continue heating for a few more seconds. Then remove the iron and let the joint cool.

Attach a nylon clevis to the throttle cable's threaded coupler and a pushrod connector to the nose gear cable (see Fig. 4-36). Feed each cable through its nylon tubing into the plane's radio compartment.

Attach the nose gear cable connector to the steering arm without its plastic retainer, move the nose gear to the neutral position, and mark the cable ½" to ¾" aft of the center of the rudder servo shaft with a fine-tip felt marker. Remove the cable with the forward pushrod connector still attached, cut it at the mark, and tin the newly cut end.

Fig. 4-32. Two or three inches of the cable should be sticking out.

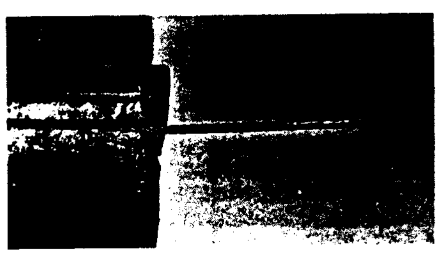


Fig. 4-33. Use the hot iron to smooth out any bumps, then remove the heat.

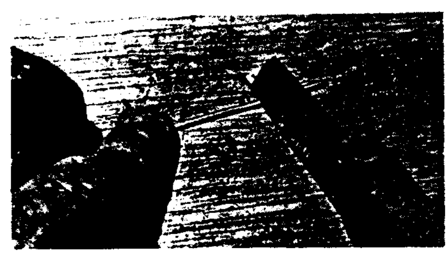


Fig. 4-34. When the solder cools, file the tinned end smooth.

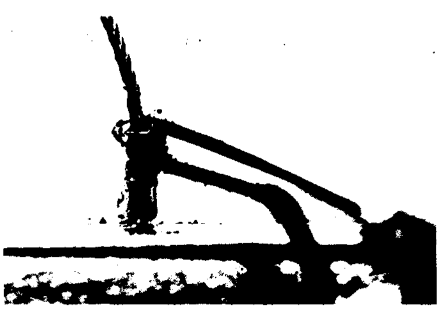


Fig. 4-35. Soldering the threaded coupler to the tinned cable. Don't heat the solder directly with the iron or you'll get a bad joint.

Fig. 4-36. Pushrod connector on the tinned steering cable; clevis on the threaded coupler of the throttle cable.

FIG. 4-37 PROPER THROTTLE SETUP

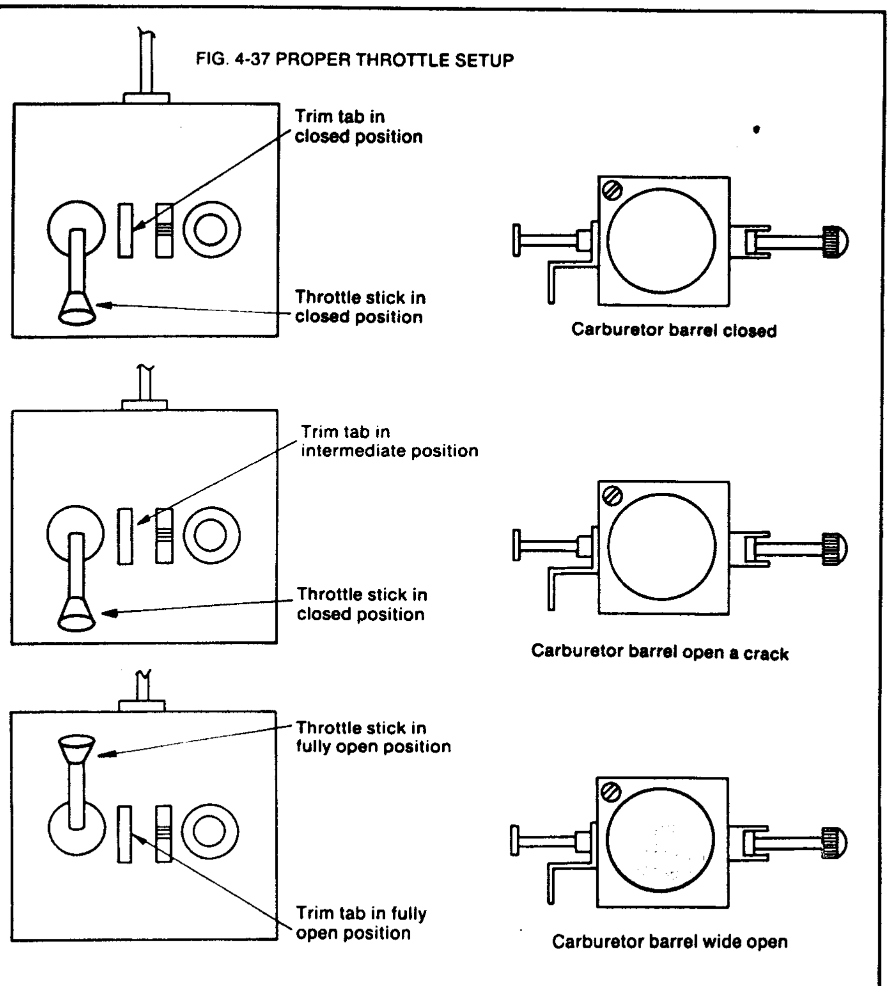
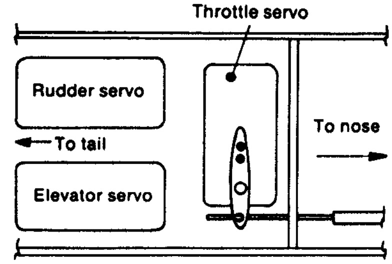


FIG. 4-39 ADJUSTABLE SERVO ARM IN THE HALF-THROTTLE POSITION



With the transmitter stick and trim lever in their middle positions, the throttle servo arm should be perpendicular to the fuselage sides.

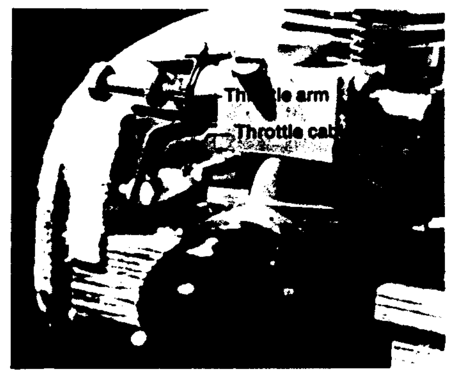


Fig. 4-38. Connect the throttle cable clevis to the throttle arm.

The solder should extend about 1½" from the end. File the tinned area smooth, then slip the cable back through its tube. Attach the forward pushrod connector to the steering arm with a plastic or nylon retainer and tighten the connector setscrew.

Slip a second pushrod connector over the tinned end of the cable inside the fuselage, but don't tighten the setscrew. Now remove the servo arm from its servo, slip the connector into the innermost hole it will fit, and clip the retainer in place. Turn on the Rx and Tx, set the rudder servo trim lever to the neutral position, and install the servo arm. Move the nose gear to neutral and tighten the servo arm. Steady the cable tubing with one hand; with the other move the rudder stick left and right. The nose gear should rotate clockwise as viewed from the top of the plane when you move the stick to the right. If the gear turns the wrong way, flip the servo reverser switch. Your first working control won't work positively until later, when you brace the cable tubing.

THROTTLE CABLE INSTALLATION

The throttle cable is installed almost the same way, but takes more tinkering to get right. To minimize frustration, use an adjustable servo arm. At this stage you just want to get the throttle adjustment set roughly. You'll fine-tune it during final radio installation, after installing the cable braces. For now you can simulate a brace by holding the cable steady with one hand as you work the Tx with the other.

Your goal is to set things up so that: 1) fully closed throttle stick and fully closed trim shut the engine off; 2) fully closed throttle stick and intermediate trim settings give a good idle; and 3) full forward stick and full forward trim give full throttle on the engine (see Fig. 4-37).

Remove the arm that comes with the throttle servo. Again, temporarily install the engine. Slide the throttle cable into its tube through the fire wall and connect the throttle cable clevis to the throttle arm (see Fig. 4-38). Manually push the throttle arm on the carburetor (not the servo) to the fully open position. Then mark the cable about one inch aft of the throttle servo.

Remove the cable, cut at the mark, tin, file smooth, then re-install in the airplane. Install a pushrod connector on the newly tinned end of the cable, slip the connector into an adjustable servo arm, and fasten it in place with the plastic retainer; however, you will not install the servo arm at this point.

Set the carburetor barrel halfway open, turn on the Rx and Tx, and set the throttle stick and trim tab at their halfway positions. Install the adjustable servo arm on the servo as shown in Fig. 4-39. The cable should be near the fuselage side. Tighten the connector setscrew, then gingerly push the throttle stick forward while holding the cable steady with your hand. This should cause the barrel to open. If it closes, flip the throttle servo reversing switch to set it right.

You'll have to play around with the length of the servo arm to obtain the correct throw. At this point you'll just want an approximate adjustment. This is how to do it.

First, loosen the connector setscrew, then move the throttle stick and trim levers to the fully open positions. The cable should slide through the connector as the servo moves. Make sure the carburetor is fully open, then tighten the setscrew on the servo arm connector. Now move the trim tab to the fully closed position and hold the cable steady with your hand as you gently close the throttle.

If the servo stalls, back off, decrease the servo arm length slightly and start the adjustment process over. Figure 4-39

FIG. 4-40 ELEVATOR AND RUDDER PUSHRODS

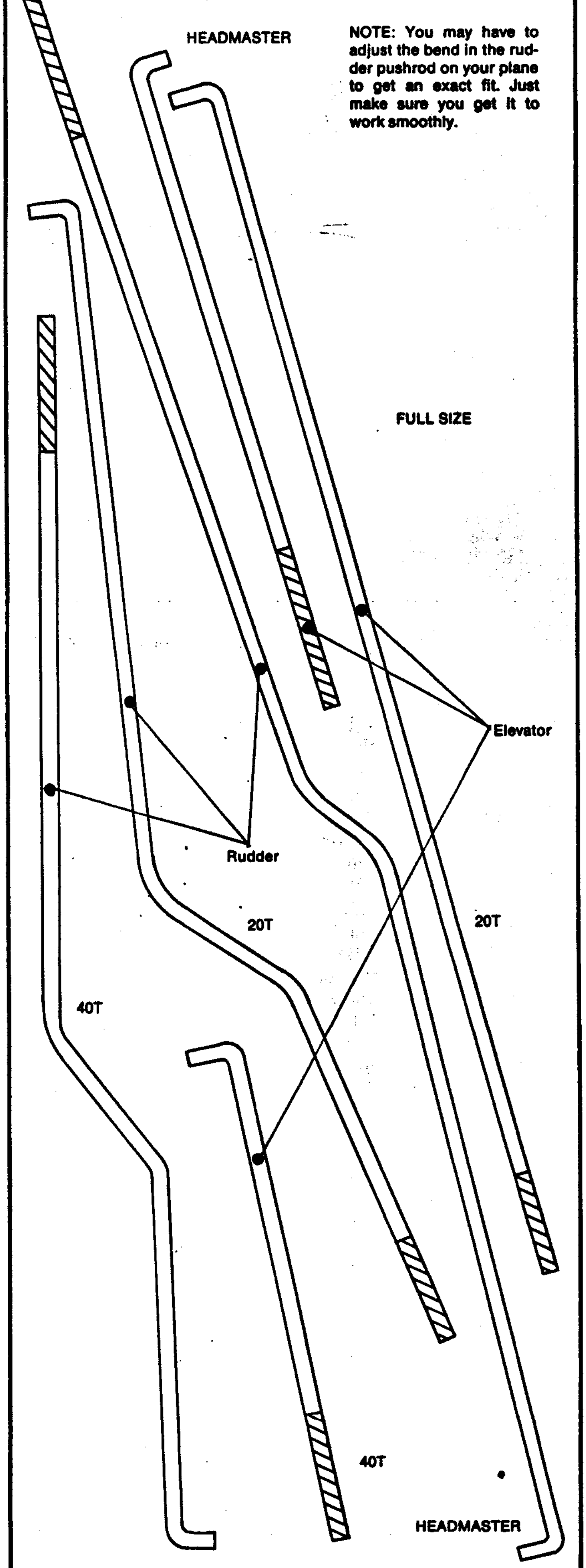


Fig. 4-41. Use Z-bender pliers to shape the wire.

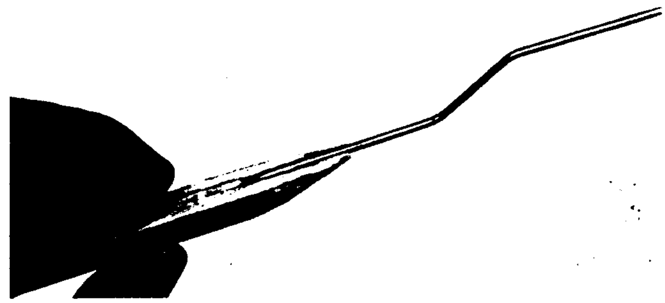


Fig. 4-42. Put the L of the rear pushrod wire into the hole this way and glue it in place.

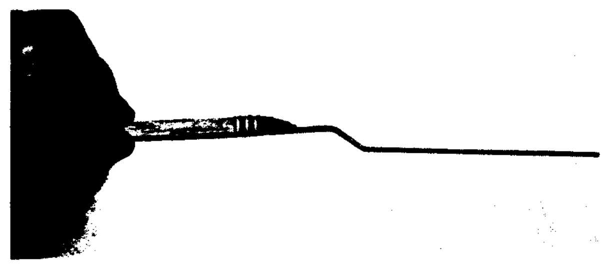


Fig. 4-43. Coat the thread with thin CA. The other pushrod is prepared the same way.

Fig. 4-44. Coax the pushrod out of its slot with a screwdriver.

shows the positions you're looking for. Don't be too picky at this point; save that for final installation.

ELEVATOR AND RUDDER PUSHRODS

The most secure way to connect a servo to a pushrod is to use a Z-bend. Unfortunately, you'll need special Z-bender pliers to do this and it will cost a few dollars. No matter; buy the thing or borrow one. The Z-bend is good insurance. If you insist on using some other technique to attach the elevator, rudder, and aileron pushrods, you're on your own. That said, here's how to make and install the pushrods.

Draw front-to-rear center lines on the top and bottom of the horizontal stabilizer and use duct tape to fasten the stab and elevator together. Tape both sides of those surfaces. Do the same with the fin and rudder.

The next step depends on whether you use wood or nylon pushrods. Check the chapter on your plane. If it says "Gold-N-Rods" right under the chapter title, skip the next section. If it doesn't you'll need wood pushrods, so read on.

INSTALLING WOOD PUSHRODS

If you're building one of the ARF models, don't use the already-made pushrods. You can make better ones, and after all this work, there's no point risking your model on questionable pushrods.

Begin by cutting the rear metal portions of the pushrods to the exact shape and length shown on the plans for your plane. For ARF kits without plans, refer to the full-size drawings in Fig. 4-40.

After you've cut and shaped the rear metal rods, you'll have a couple of pieces of unthreaded wire left. If they're long enough, you can use them for the forward metal parts of the pushrods. If they're not, or if it's a close call, take two new rods and cut off the threaded portion. One way or another, you now have two unthreaded pieces of wire. As shown in Fig. 4-41, make a Z-bend in one end of each and set both aside for later use.

MAKING THE ELEVATOR PUSHROD

Start with the pushrod material that comes with your kit — unless you have an ARF kit and I just told you to throw that stuff out. If the wood part is hardwood, use it. If it's soft, throw it out and replace it. For planes with .25 or smaller engines, use ¼"-square medium or hard balsa. For larger planes, use 5/16"-square balsa for the pushrods.

Drill a 1/16" hole about 1¼" from one end of the wood rod, then make a slot from the hole to the near end of the pushrod. To make the slot, cut a thin wedge with your razor blade, then use the threaded end of a metal pushrod as a file to enlarge the slot. Trial fit the metal portion by sinking the L of the rear pushrod wire (the one threaded at one end) into the hole as shown in Fig. 4-42. About one-third of the pushrod's diameter should stick out above the wedge.

The L should not protrude from the other side of the wooden rod. If it does, remove the metal portion and cut off just enough so it doesn't. Now carve the wood rod to shape, slip the metal portion in place, wrap it with thread, and secure with thin CA (see Fig. 4-43).

Once the CA has cured, thread the pushrod through the fuselage from the radio compartment. On some planes the pushrod exits through the open rear end of the fuselage. On some others it exits through a slot in the fuselage side. If your plane has a slot, move the pushrod around until you can see the threaded end through the slot, then ease it out with a small screwdriver and install a nylon clevis so it doesn't slip back in (see Figs. 4-44 and 4-45). Then connect the clevis to the elevator horn, which is not yet attached to the elevator (see Fig. 4-46).

Fig. 4-45. Screw a clevis onto the pushrod so it can't slip back in. Adjust the clevis until the same amount of thread lies on either side of it.

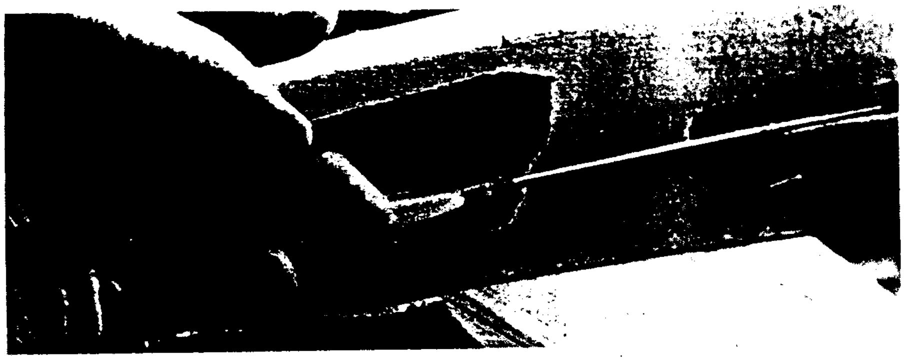


Fig. 4-46. Connect a control horn to the pushrod.

Now fit the horizontal stabilizer (stab) onto its saddle (slot) and pin it in place. Tape the horn to the elevator so the clevis pin is even with the hinge line (see Fig. 4-47). The base of the horn need not be parallel to the hinge line, but it must be aligned with the clevis (see Fig. 4-55). Using the horn holes as guides, bore screw holes through the elevator with your reaming tool. Then, see Fig. 4-48.

Put the pushrod's forward end over the elevator servo. Figure 4-49 shows how. Locate one of the wires with a Z-bend in it, remove the servo arm, and insert the Z-bend (see Fig. 4-50).

Turn on the Rx and Tx, then replace the servo arm with the Z-bend in it. Align the metal rod with the wood one and mark the metal one 1½" aft of the mark on the wood rod using a fine-tip felt pen. Remove the metal rod, cut it at the mark, and bend a ¼" L in it. The L and Z-bend should lie in the same plane. If they don't, place one end of the rod in a vise and twist the other end until they do. Replace the servo arm with the Z-bend in it and again align the metal rod with the wood one. Press the L into the wood to mark it.

Turn off the radio system, remove all parts of the pushrod assembly (but not the control horn), and cut the wood rod where you marked it with the pen. Drill a 1/16" hole where you marked it with the metal rod, cut a wedge from the hole to the near end of the wooden rod, and attach the Z-bent rod with thread and CA as before.

The elevator pushrod is now complete. Install it to be sure it fits perfectly, and leave it in place as you make and install the rudder pushrod, which is done exactly the same way.

You can skip the next section and go directly to the section on testing the control system.

GOLD-N-ROD PUSHRODS

If your plane requires Sullivan Gold-

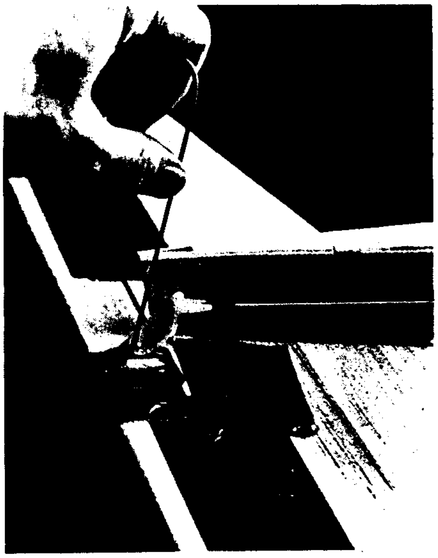


Fig. 4-47. Tape the control horn in position, then use it as a guide to bore the screw holes through the control surface with your reaming tool.

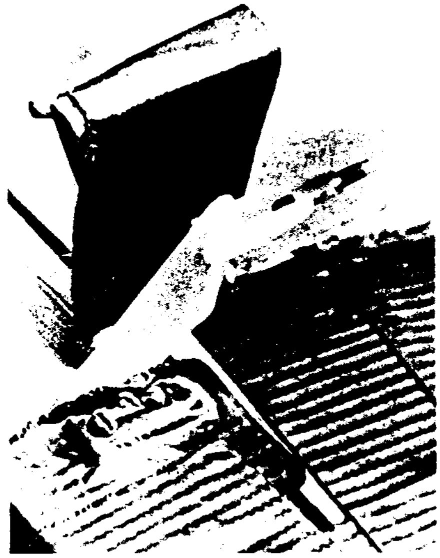


Fig. 4-48. Put on the horn hold-down screws, but don't attach the backplate to the other side of the control surface.

Fig. 4-49. Mark the wood rod about one inch aft of the servo case.

N-Rods, here's how to install them. Your first step is to cut exit holes in the fuselage sides. See the chapter on your plane for the exact positions. As shown in Fig. 4-51, I cut two sets of holes in the PT-20. The first set went where THE MANUAL said to put them. Unfortunately, with the setup I used, those holes didn't work, so I had to cut the second set. I simply plugged the extra holes with scrap balsa before covering the model. Had I not done a preliminary installation, the result would have been a mess.

Having cut the exit holes, slip pieces of outer Gold-N-Rod through them. These should extend out the rear to within two inches of the end of the fuselage and forward into the fuselage to within about an inch of the aft edges of the rear servo cases. Glue the outer rods in place at the tail with thin CA, then reinforce the joints with five-minute epoxy (see Fig. 4-52).

Slip inner rods into place and cut them an inch longer than the outer ones. Remove them from the fuselage and screw one of the fully threaded rods that come with your Gold-N-Rod set into the inner elevator rod (see Fig. 4-53).

Starting from the tail, feed the inner rod through the outer rod until it emerges in the radio compartment.

Fig. 4-50. If necessary, ream the servo arm to accept the wire rod.

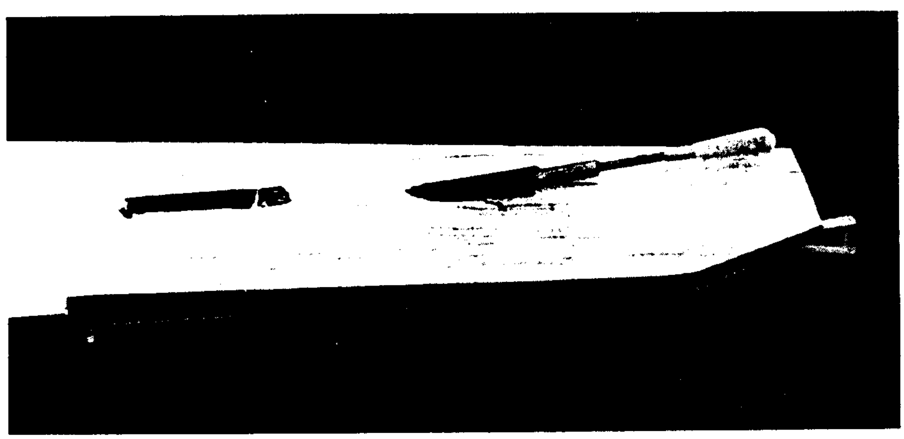


Fig. 4-51. Oops! I cut the first set of pushrod holes in the wrong places. Makes me glad I did a preliminary radio installation.

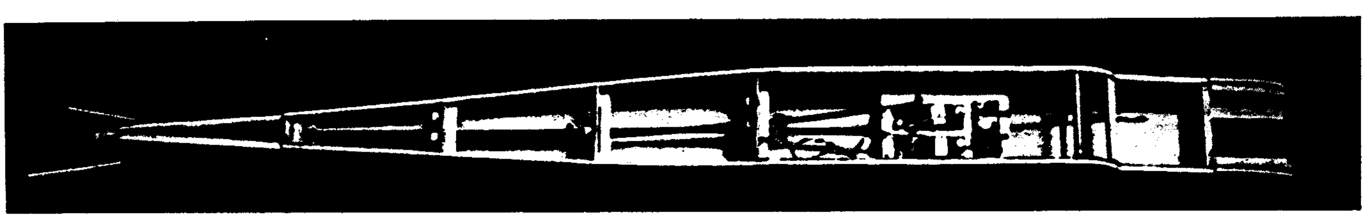


Fig. 4-52. Here's a complete view of the Gold-N-Rod installation.

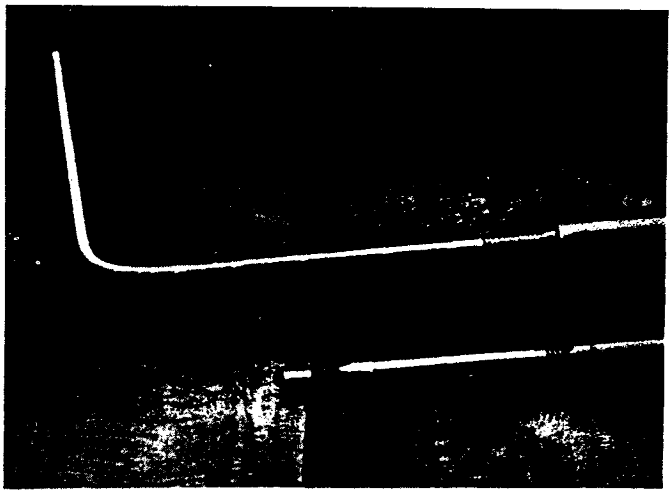


Fig. 4-54. Cut the rod and bend it as shown to make a handle so you can screw it into the Gold-N-Rod.

Fig. 4-55. The front of the control horn need not be parallel to the leading edge of the elevator, but it must be aligned with the clevis.

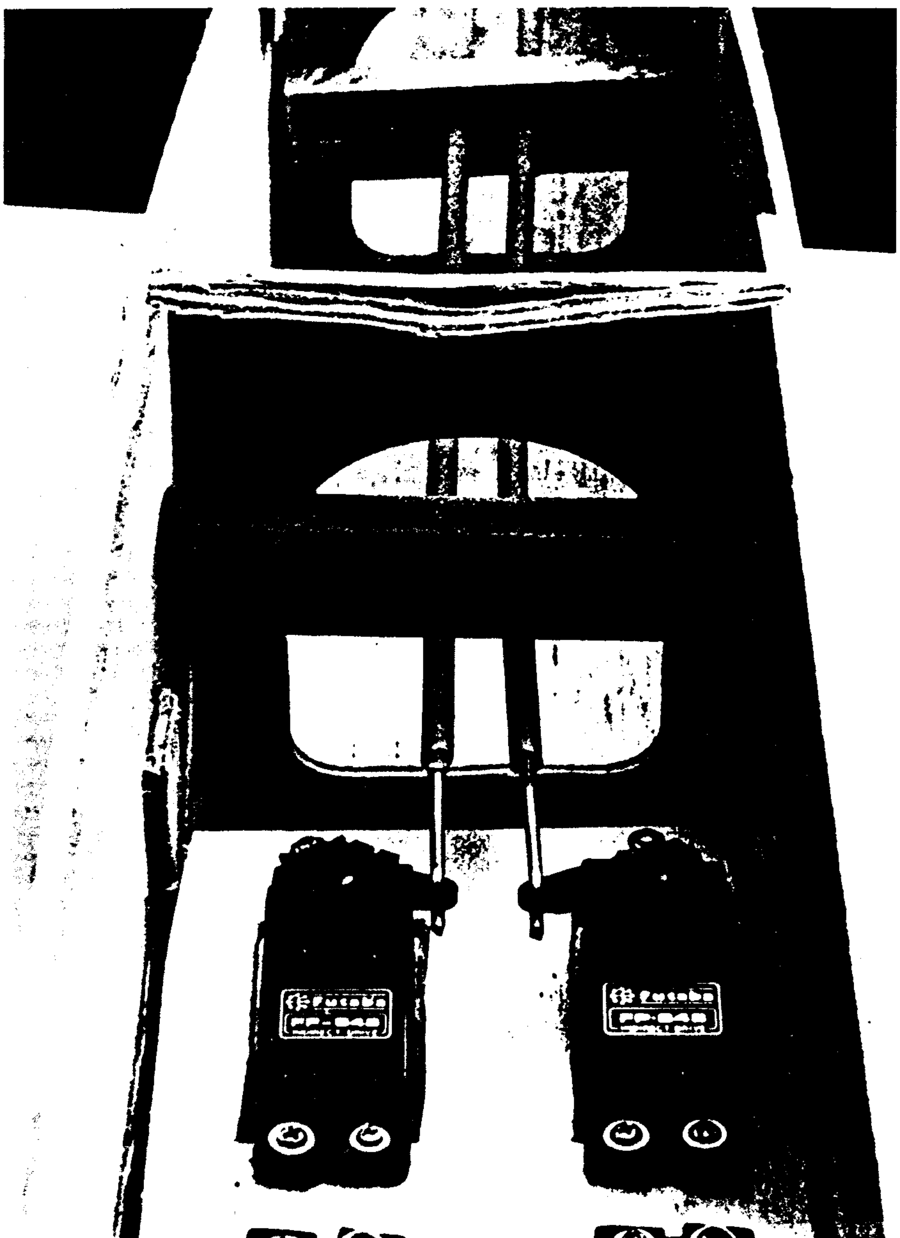


Fig. 4-59. The Gold-N-Rods connected to servos and braced.

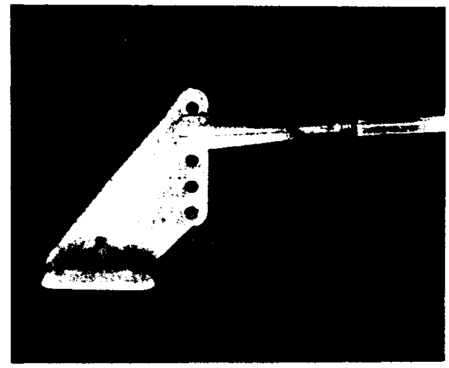


Fig. 4-53. Screw a completely threaded rod into the inner Gold-N-Rod to a depth equal to about half its length or half an inch. Then attach a clevis and clip it to a control horn.

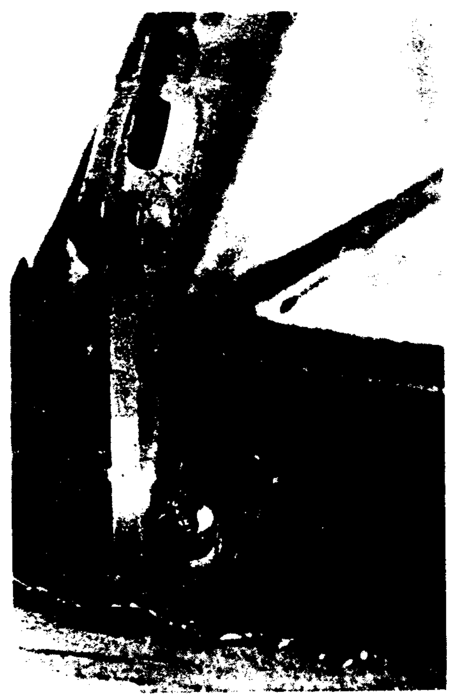


Fig. 4-56. Install the screws, but don't install the horn backplate.

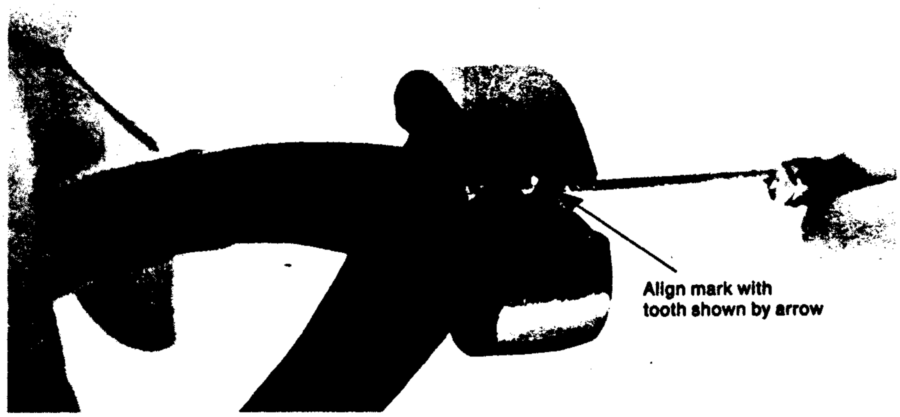
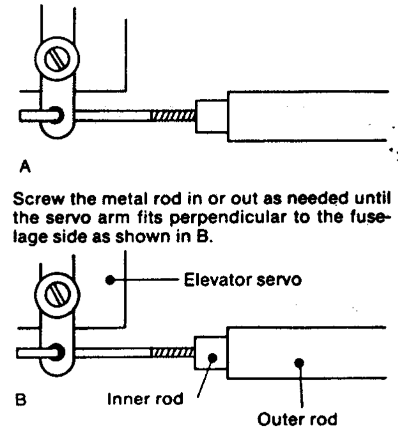


Fig. 4-57. To get the Z-bend in the right place, you have to set the mark on the rod over the tooth identified by the arrow.

FIG. 4-58 ADJUSTING LENGTH OF GOLD-N-ROD AT THE SERVO END



Now screw the threaded end of a partly threaded metal rod into the nylon inner rod inside the radio compartment. You'll have to shorten the rod to do this, then make a 90° bend at the unthreaded end to use as a handle (see Fig. 4-54).

Line up the elevator horn so that its clevis holes are even with the elevator hinge line and tape the horn in place. Using the horn holes as guides, make screw holes through the elevator with your reaming tool (see Figs. 4-47, 4-55 and 4-56). Then, see Fig. 4-48.

Return to the radio compartment and guide the partly threaded metal pushrod over its servo arm and mark it at the point where it will be connected. Make a Z-bend there (see Fig. 4-57). You will have to unscrew the rod to do this. Now remove the elevator servo arm. Connect the Z-bend to the servo arm, then screw it back into the inner Gold-N-Rod. Don't attach the servo arm to its servo yet.

Turn on the Rx and Tx, center the trim tabs, and temporarily install the servo arm on its servo. You'll probably have to adjust the rod by screwing it in or out before you can get the arm in its proper position as shown in Fig. 4-58. Once you've done that, screw the servo arm in place. Now repeat the process for the rudder pushrod.

Finally, install braces inside the fuselage to prevent the Gold-N-Rods from flexing. To make a brace, drill a pair of ¼" holes in ¼" x ¾" balsa scrap about as long as the fuselage is wide. Position the holes as shown in Fig. 4-59. Split the brace lengthwise so you cut the holes in half. Now epoxy the bottom half of the brace into position with the outer Gold-N-Rods sitting in the half-holes, then glue the top half of the brace over the bottom half as shown in the Fig. 4-59. Brace the rods at each former. If you don't, you're asking for a crash.

TESTING THE CONTROL SYSTEM

(Applies to both wood pushrods and Gold-N-Rods)

Remove the tape from the right side of the rudder/fin joint and the top side of the elevator/stab joint. Turn on the Rx and Tx and gently apply a touch of down elevator and left rudder. If either surface moves the wrong way, flip the appropriate servo reverser to correct it. Once you're sure of the direction, apply full down elevator and full left rudder. The control surfaces should move freely and not interfere with one another. Replace the tape you removed and peel the tape off the left side of the fin/rudder and the bottom side of the stab/elevator. Apply up elevator and right rudder. If anything binds or otherwise causes trouble, fix it now.

The preliminary radio installation is complete. Remove everything that's not glued to the plane, install any parts you need to add before covering (e.g. the fuselage top sheeting), and get ready to cover your plane.

5. Covering the model

If you're building one of the ARF models, it's already covered and you can skip this chapter. Otherwise you'll have to cover the plane with an iron-on plastic film.

When you open a roll of this stuff, you'll find that the covering material has a shiny outer side and a dull inner side, and that stuck to the inner side is a clear or translucent backing. To apply the covering, pull off the backing, place the colored film glue-side down on the model, and apply heat. The heat melts the glue, allowing it to stick to the wood beneath. That's the general idea, but naturally there are details to fill in.

CHOOSING THE COVERING MATERIAL

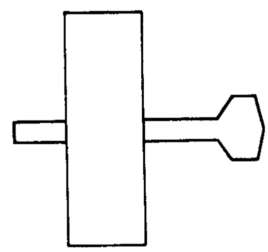
If you choose Coverite's Black Baron films, you'll find achieving a wrinkle-free job with it is easier than with most other brands. Black Baron has a lot of shrink to it, which means it requires only minimal skill to apply smoothly. It also weighs less than most covering films, which is a big plus.

THE COLOR SCHEME

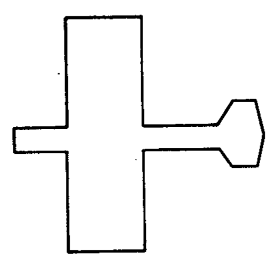
If you're new to RC flying you probably don't know how much influence the plane's color has on how well you can fly it. That's right: Color affects flight performance — significantly (see Fig. 5-1). Plenty of beginners crash because they get disoriented. A sky-blue plane against a blue sky is hard to see. A white or gray plane against an overcast sky tends to vanish — and crash. And even experts have trouble with dark blue and black planes. The easiest colors to see are those that correspond to the longest visible wavelengths. Bright reds and oranges are best, and bright yellows aren't bad.

The problem isn't just seeing the plane, but figuring out what it's doing. If it's far out, as it will be most of the time when you're learning, it's not obvious whether it's coming or going; if the top of the wing is one color and the bottom another, you can sort things out. The approximate rule is this: If you see the color of the top of the wing, the plane is turning toward you. If you see the bottom color, it's either not turning or is turning away from you. So make the top of the wing and the bottom two easily discernible colors. I strongly recommend bright red or orange on top and bright yellow on the

Top of wing is white, rest of plane is orange. Plane is just above horizon.



Plane is banked left and turning toward you.



Plane is banked right and is turning away from you.

FIG. 5-1 ORIENTATION AND COLOR

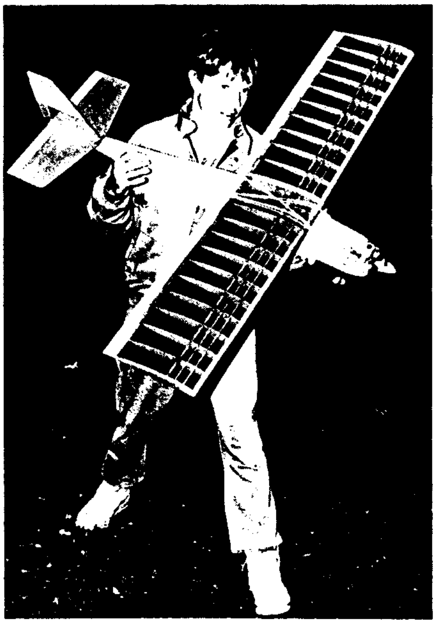


Fig. 5-2. This wing is not uncovered; it's translucent orange on top and translucent yellow on the bottom. In flight it's hard to determine what the plane is doing.

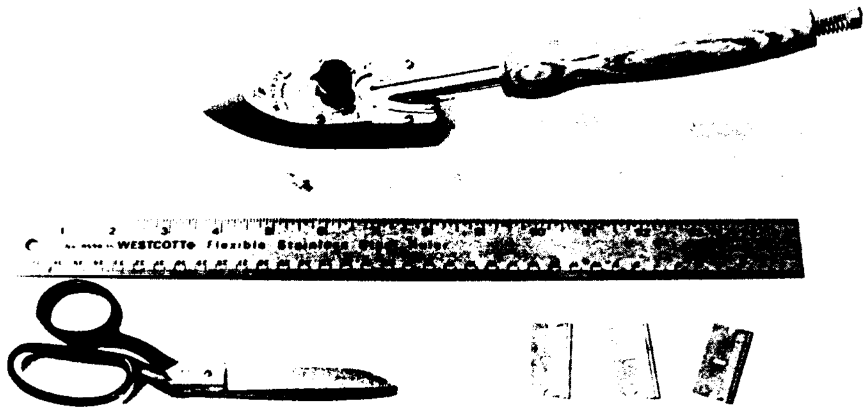


Fig. 5-3. Here are some of the basic covering tools.

Fig. 5-4. To cover imperfections, fill the blemishes with plenty of vinyl spackle. When it's dry, sand it smooth.

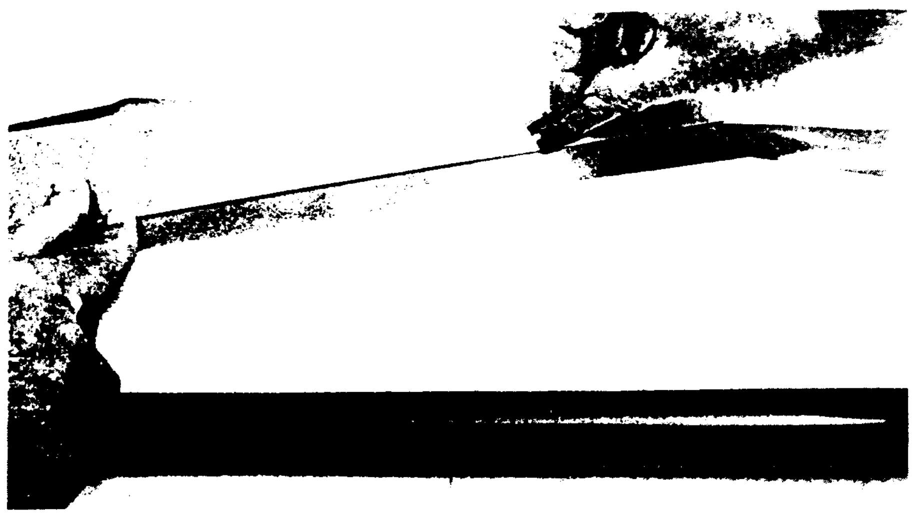


Fig. 5-5. Cutting film with a straightedge and a razor blade. Usually you want film about 1" to 1½" oversize in every dimension.

bottom. With that color scheme, a glint of red or orange in the distance tells you the plane's turning for home, while yellow tells you you'd best start giving control inputs before it flies away.

Finally, let me caution you about translucent colors. They look pretty up close, but when the sun hits them, you see neither the color of the top nor the color of the bottom, but light reflected by both top and bottom panels and light filtered through both panels — which won't tell you which side of the wing you're seeing (see Fig. 5-2). Decorate the fuselage and tail however you like, but make the top of the wing a bright, solid, easily seen color and the bottom a different bright, solid color.

TOOLS AND TRICKS OF THE TRADE

Your constant allies in covering the plane will be lots of fresh razor blades, a couple of matte boards, two straightedges (preferably 18" and 48"), and a sealing iron. You'll also occasionally use sharp scissors and facial tissues (see Fig. 5-3).

The matte boards are great cutting boards. If you cut directly over your workbench, not only will you scar it, but the razor blade will follow the wood grain, yielding a ragged cut which causes trouble in some operations. If you cut over the matte board, the razor will follow the straightedge and give a clean cut.

PREPARING THE WOOD FOR COVERING

To achieve a pretty covering job, fill imperfections with a material such as DAP (a vinyl spackling formulation) or a hobby product such as Model Magic. Figure 5-4 shows how to do it easily.

Whether you do this or not, you need to sand the wood with fine sandpaper. This creates lots of dust, which you'll have to vacuum off before covering the model.

PREPARING THE FILM FOR USE

To cut the film, lay it face down on the matte board and place a straightedge over the line you want to cut. Put a razor blade against the straightedge, press the straightedge firmly against the covering, and pull the blade along the length of the cut (see Fig. 5-5).

The next trick is to remove the back-

Fig. 5-6. If the backing on the covering film has an end piece, grip a loose end and pull it off.

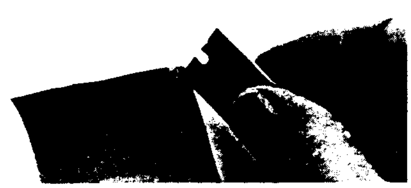


Fig. 5-7. If there's no loose end, you'll have to make one by roughing up a corner of the backing with a razor blade.

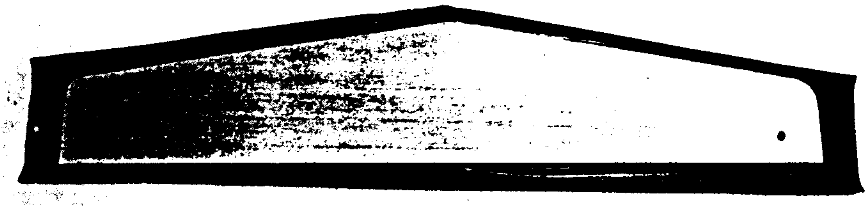


Fig. 5-8. Cut the film to size, leaving a generous excess (at least 1") all around.

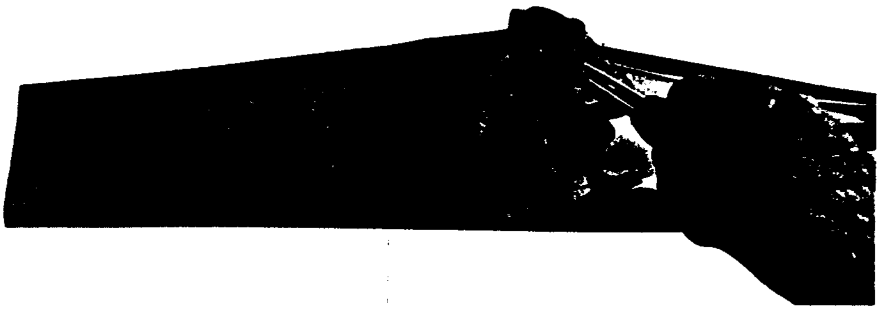


Fig. 5-9. Smooth the covering with your hands, then tack it with a sealing iron at the leading and trailing edges of both tips and at the center.

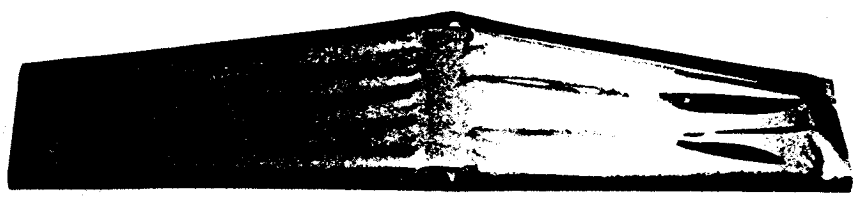


Fig. 5-10. Iron the center section down, then pull loose the tacked ends at both tips.

Fig. 5-11. Seal the film securely to the wood, making sure you always work toward the open areas to avoid trapping any air bubbles.

ing. Figures 5-6 and 5-7 show how. **Caution: If you're not careful, the film can twist around and stick to itself when you remove the backing, in which case you'll probably have to throw it out. To avoid this, don't pick the film up to separate the backing. Leave it flat on the cutting surface. As the backing comes off, it creates enough static electricity to hold the covering against the bench.**

SETTING THE TRIM IRON TEMPERATURE

Before covering any part of your model, practice with scraps. You'll get a feel for what you're doing, and you'll have a chance to set the trim iron temperature at the same time. If it's too cool, the film won't stick well. If it's too hot, the film will shrink too much and wrinkle, or even melt. For starters, set the iron in its middle range, wait about three minutes, then try to iron a bit of covering to a scrap of wood. You'll probably have to try two or three different settings to get it right. And don't get complacent; the iron temperature can change while you're using it, so if your film misbehaves later, adjust the iron temperature again.

CLEANING THE TRIM IRON

As you cover the model, especially as you stick down the edges, colored glue will cling to the iron; if you don't get it off, the glue will get on everything you work with. Just rub it off the hot iron with a dry facial tissue.

COVERING PRACTICE

If your model has a hatch cover, start there so you won't waste much material if you mess up. If there's no hatch cover, a fin or rudder will do.

COVERING SOLID WOOD AREAS

With the aid of the following figures, I'll cover a horizontal stabilizer to demonstrate most of the techniques you'll need to cover any solid structure.

First, cut the film to size with a razor blade and a straightedge (see Fig. 5-8). Remove the backing and lay the film over the piece to be covered. Smooth the film over the wood. Figure 5-9 shows what to do next. Then, iron the center section. Don't use a lot of pressure when ironing the center — if it takes more than the weight of the iron, increase the temperature. If the material wrinkles a lot before you can iron it down, the iron is too hot. With the center section ironed in place, pull free the tacked areas (see Fig. 5-10). Then begin ironing from the center out toward the tips and toward both the leading and trailing edges. By ironing away from the areas that are already stuck down, you leave an escape route for air that otherwise would be trapped, creating bubbles (see Fig. 5-11).

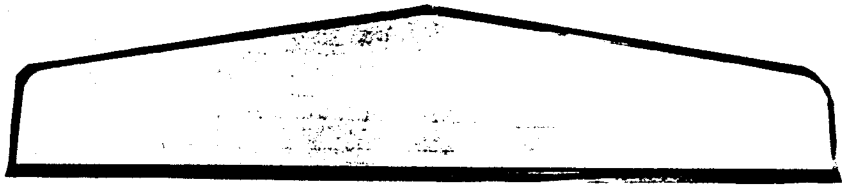


Fig. 5-12. Trim off most of the excess covering, leaving just enough to wrap around the leading and trailing edges and the tips.

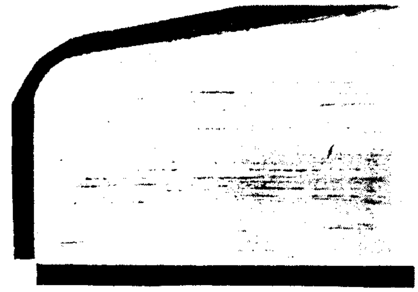


Fig. 5-13. Cut out a little rectangle of film at each square corner.

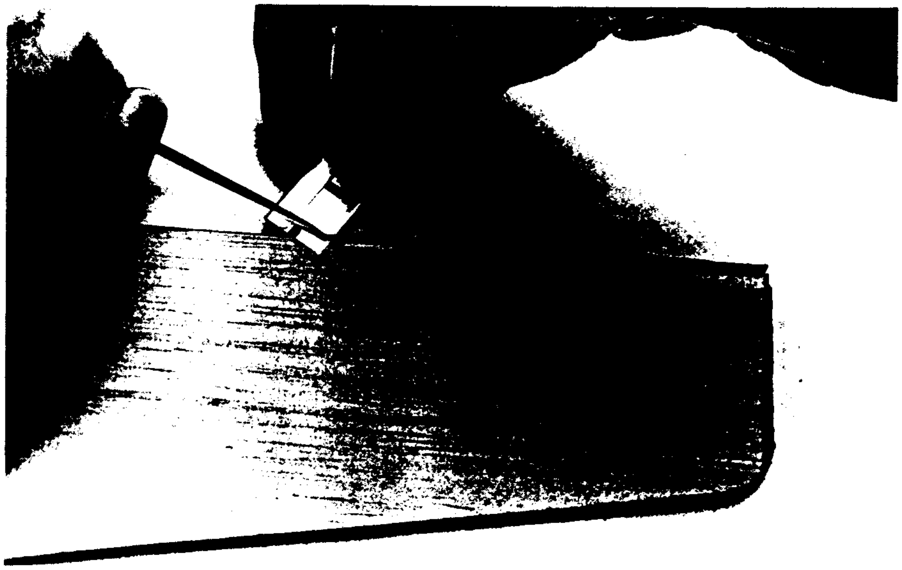


Fig. 5-15. Wrap the film around the leading and trailing edges and tips, but don't seal it to the top of the stab. Trim off excess as shown.

Fig. 5-14. Slice the covering every $\frac{3}{16}$" or so for rounded corners.

Fig. 5-17. The finished stab should look like this.

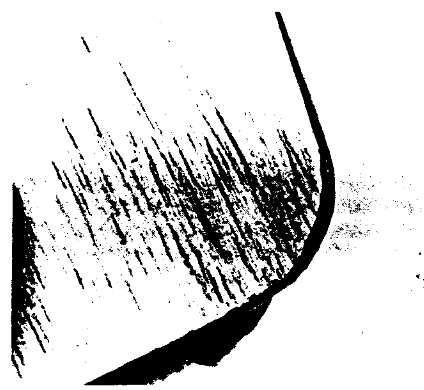


Fig. 5-16. When you've sealed all loose ends to the stab, all film should be attached smoothly to wood.

With the covering smoothly ironed onto the wood, turn the piece over and trim off the excess film (see Fig. 5-12).

Don't iron the excess film to the wood yet; first you'll have to cut the square corners as shown in Fig. 5-13. On the rounded parts, you'll need to slice the film. Figure 5-14 shows how. After you've made these cuts, wrap the film around the leading edge, trailing edge, and tips with your trim iron, and use a razor blade to slice off any excess (see Fig. 5-15). Finally, go over all the loose edges and seal them to the stab (see Fig. 5-16).

Repeat the whole procedure to cover the top of the stab and be sure to overlap the bottom covering all around by about ¼". The seams should be just out of sight underneath the stab. Seal every bit of overlap to the first piece of film. This film-to-film contact, more than any film-to-wood contact, assures you that wind and fuel won't rip the covering off (see Fig. 5-17).

Fig. 5-18. To get rid of a bubble, puncture it with a fine needle to let the air out. Then touch up the spot with a hot trim iron.

If you trap air bubbles under the covering, puncture them a few times with a needle to let the air out and touch up the spot with an iron (see Fig. 5-18).

When covering larger structures, notably the fuselage, you'll need several pieces of film. For one thing, the fuselage may be too long to cover in a single piece. It's also a complicated shape with curves in it (see Fig. 5-19). There are three rules for covering with multiple pieces: Rule One: Cover the bottom first, then the top. This keeps the seams as inconspicuous as possible. Rule Two: Cover the rear first, then the front. This allows the seams to face away from the wind in flight. Rule Three: Don't try to cover complicated shapes with a single piece of film. It doesn't work (see Fig. 5-20).

COVERING OPEN FRAMEWORK

Covering the open framework of a

wing is more complicated. Start with the bottom panel on one side (see Fig. 5-22). Cut a sheet of film at least 1½" oversize in every direction. Remove the backing and lay the film glue-side down over the framework. Position it so the inner edge is about ¼" beyond the center and trim to fit the torque rod (see Fig. 5-23). Smooth the covering with both hands and tack the corners with the trim iron. Now seal the center section to the wood with your sealing iron (see Fig. 5-25). Seal the covering at the wing tip rib (see Fig. 5-24) and tack it at quite a few points along the leading and trailing edges as shown in Fig. 5-26. Hold the film as you do this, but don't pull it too tight. With the film tacked and the center section firmly ironed down, cut the film so it will fit around the aileron indentations (see Fig. 5-27).

Finally, seal the covering along the leading and trailing edges. Trim off the excess with the razor blade, and seal loose ends to the wood (see Fig. 5-28).

Shrink out wrinkles by running the sealing iron gently over them. Just glide the iron, holding it so it barely touches the film (see Fig. 5-29).

The second bottom wing panel is covered the same way with this exception: After you have positioned the film, smoothed it out, and tacked the cor-

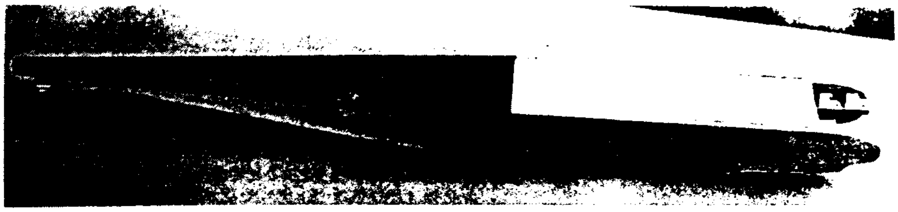


Fig. 5-19. For larger structures you'll need typically two pieces of film for the fuselage bottom, two for each side, one for the top, and small pieces to fit the windshield, cowl, and so on.

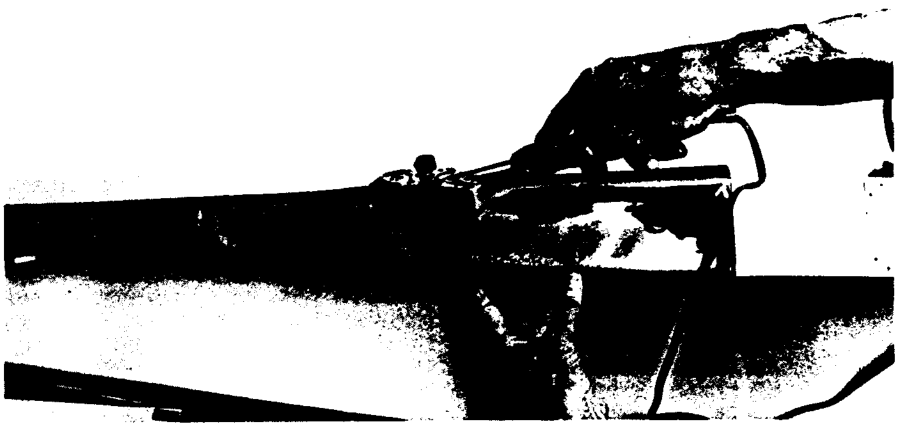


Fig. 5-20. The covering procedure for larger structures is the same, but work from the bottom up and from the rear forward. Don't try to cover any complicated shape with a single piece of material.

Fig. 5-22. Cut a piece of material big enough for one wing panel, leaving a generous excess all around.

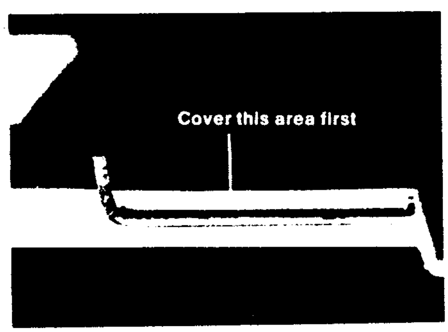


Fig. 5-21. Cover the area behind the torque rod before you cover the whole wing on this plane.

Fig. 5-23. Trim the center to fit around the torque rod.

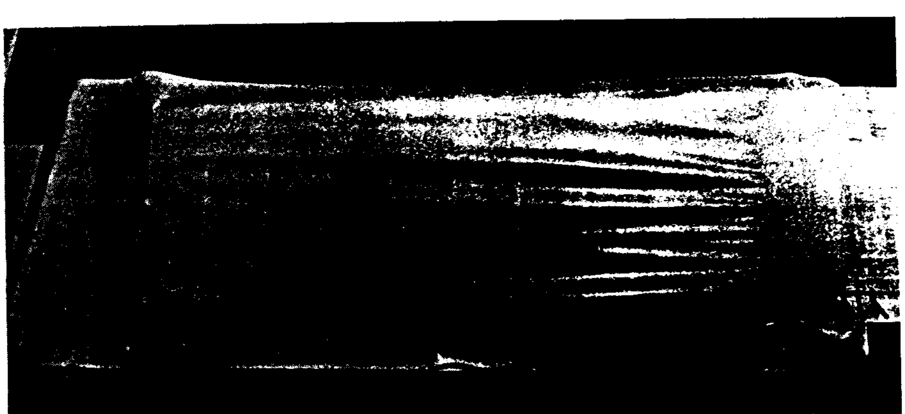


Fig. 5-25. Seal the center section to the wood. Work outward to avoid trapping air.

ners, you have to seal it where it overlaps the first panel. Once you've finished this, you'll have to work from the overlap out toward the leading edge, trailing edge, and wing tip. Working back toward the center will create air bubbles.

The top wing surfaces are done much the same way. However, a couple of models don't have wood sheeting on the upper center section. On these planes, attach the film to the center section spars and ribs as shown in Figs. 5-30 and 5-31. Note that excess film is sealed to the side of the center rib. You obviously can't do this with the second top panel, so apply it the same way you did the second bottom panel, just overlapping the first panel by ¼" or so.

I've shown you only a couple of pieces, but the same techniques can be adapted to covering the rest of the airplane.

After you've flown the plane a few times, you'll notice wrinkles cropping up. Gently shrink the covering with your trim iron to get rid of them.

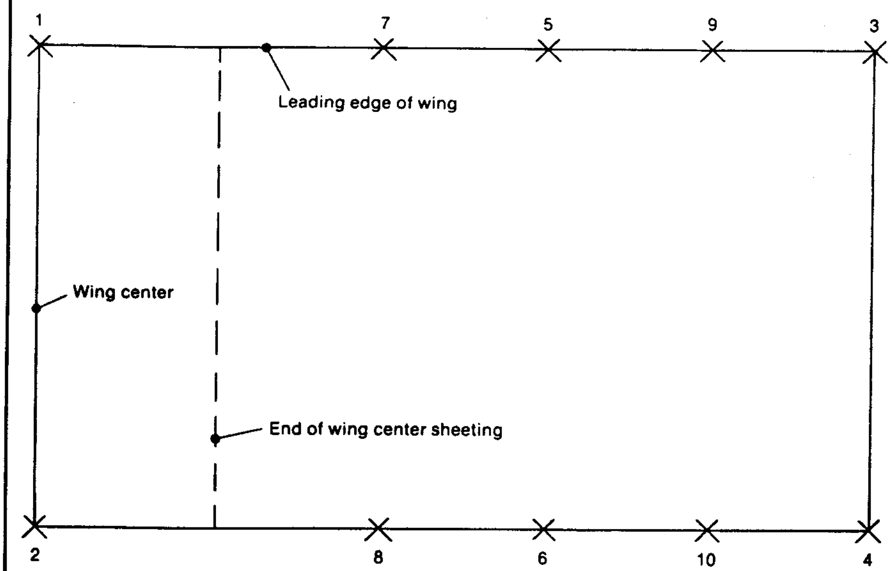


FIG. 5-26 WING TACKING SEQUENCE

After tacking at the four corners, iron the covering to the center planking and tip rib, then tack the leading and trailing edges in the order shown.

Fig. 5-24. Sealing the covering to the wing tip rib.

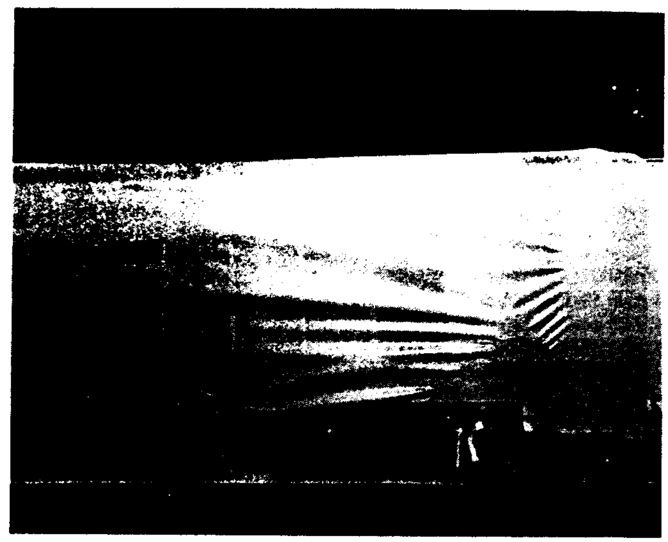


Fig. 5-27. Seal the center area near the aileron indentation, then cut the film as shown.

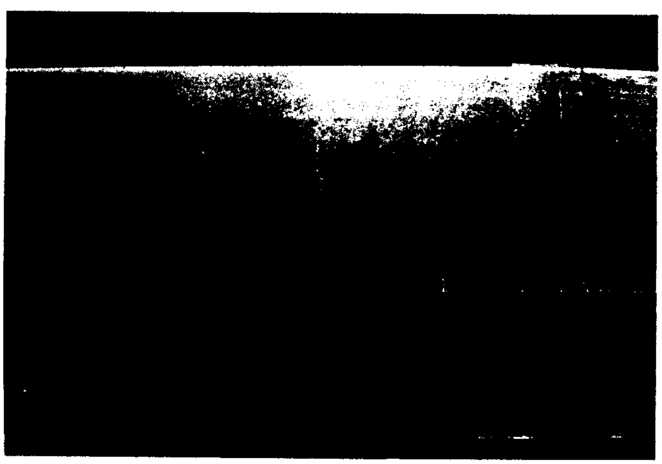


Fig. 5-28. Here's the covering sealed along the leading and trailing edges.

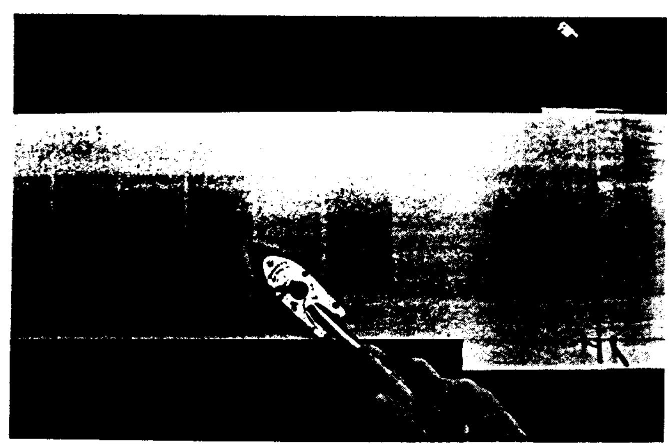


Fig. 5-29. Glide the trim iron gently over the wrinkles to shrink them out. You may need to raise the trim iron temperature a little, but be careful not to melt the covering.

DECORATING

Trainers get banged up a lot, so you don't want to spend weeks decorating your first one. However, a little striping to separate colors and a stripe or two down the fuselage side can give you a striking finish without a lot of work. You can buy stick-on stripes in various sizes and colors. Just make sure they're fuelproof; not all are.

If you're willing to spend extra time, you can make stripes from covering film and iron them in place. I keep a roll of black film around for just that purpose. Cut the stripes with your long straightedge over the matte board, then just iron them in place.

Once the pieces are all covered and striped, you can start putting everything together to make an airplane, which is the subject of the next chapter.

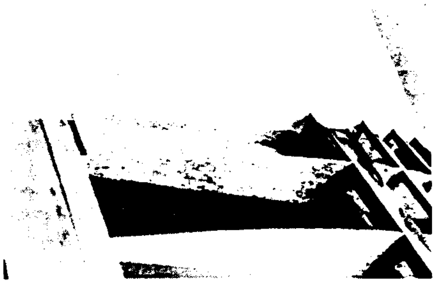


Fig. 5-30. If your plane has no top wing sheeting, cut the film on the center of the first top panel as shown.

Fig. 5-31. Then, seal it to the center rib and spars.

6. Post-covering assembly

Now all the pieces you've built will start coming together to look like an airplane. This is also the process of seemingly endless odds and ends, all of them important.

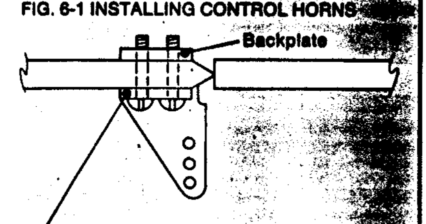
ATTACHING CONTROL HORNS

You've already bored holes in the elevator and rudder for the control horns. Find the holes and insert the screws through the horns and control surface holes and screw the backplates in place. Tighten firmly, but don't strip the backplates. If you do strip one of them, place a dab of five-minute epoxy over the screw where it comes out of the backplate. When it cures, the epoxy should hold the screw in place (see Fig. 6-1).

HOLD-DOWN DOWEL INSTALLATION

If the kit dowels are too short (see Fig. 6-2), cut your own from hardwood dowel stock of the same diameter as the dowels supplied in your kit. Round off the ends slightly, position the dowels in the fuselage, and glue them in place.

FIG. 6-1 INSTALLING CONTROL HORNS



Tighten screw firmly, but don't crush wood or strip backplate. If you should strip one backplate hole, coat the thread with epoxy as it emerges from the backplate.

PAINTING AND FUELPROOFING

With the dowels installed, you can fuelproof all the exposed wood parts — with thin CA or paint (see Fig. 6-3). Try to avoid getting paint into blind nuts, but if you do, clear it out right away by threading an amply greased screw through the nut. Give the paint at least 24 hours to cure (preferably a few days) before subjecting it to pressure from rubber bands on the dowels or fuel from an operating engine.

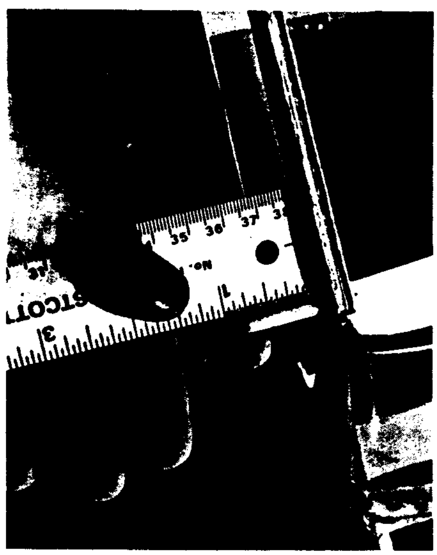


Fig. 6-2. Make sure the wing dowels protrude at least ⅞" from each side before gluing them in place.

FUEL TANK INSTALLATION

Replace the fuel tank and its foam rubber padding. The tank should touch only foam rubber, not wood or metal. Make sure there are no kinks in the fuel lines. Finally, seal the area where the fuel line passes through the fire wall with silicone glue if that's feasible on your model (see Fig. 6-4).

LANDING GEAR INSTALLATION

Simply replace the nose gear bearing, steering arm, nose gear strut, and the main gear that you took off before covering. When you install the nose gear, also install the steering cable. Tighten the steering arm pushrod connector setscrew at this time. After the engine goes in, you won't be able to get at it.

ENGINE INSTALLATION

You've already had the engine in and out of the airplane, but this time is for keeps, so before you do anything else, make sure all the screws and bolts in the fire wall are good and tight. Then do the same for all the screws and nuts on the engine itself — especially the screws that hold the backplate in place. Then bolt the engine to its mount.

INSTALLING THE HORIZONTAL STABILIZER

I've provided two sets of instructions for this operation. If you're building a kit in which the stab sits on top of the fuselage or underneath it, use the first set (conventional kits). If the stab fits into a slot, use the second set of instructions (ARF kits).

Fig. 6-3. Thin CA will do the job, but the plane will take on an even prettier look if you brush on a polyurethane paint that complements the covering color.

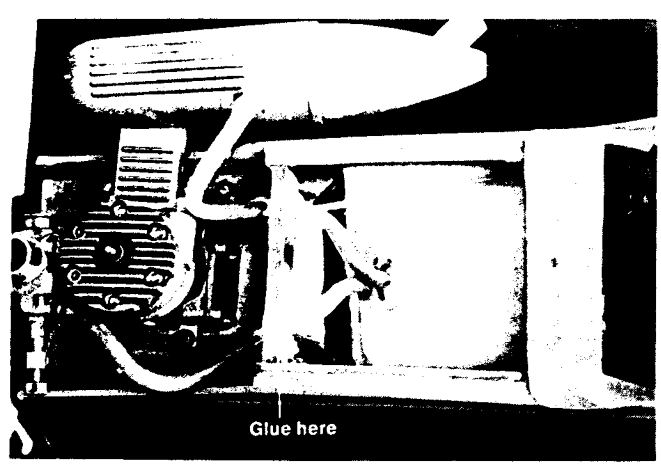
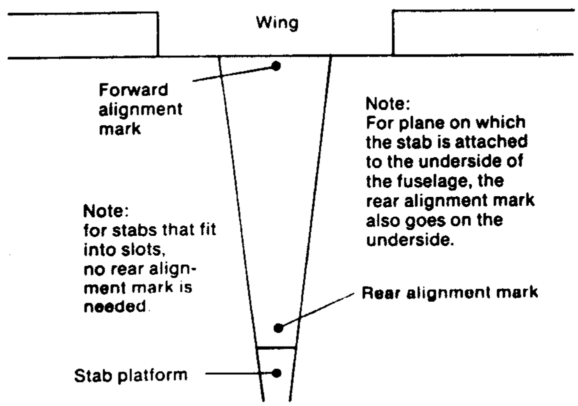


Fig. 6-4. Sealing the fuel lines with silicone glue prevents fuel from seeping into the tank compartment.

FIG. 6-5 ALIGNMENT MARKS ON FUSELAGE



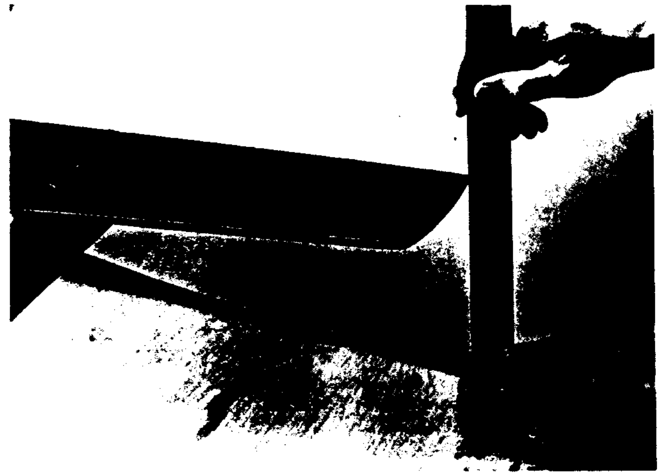


Fig. 6-6. The stab tips must be the same height above the bench.

Conventional Kits

Start by making three alignment marks with a ballpoint pen. (You can erase these later with a tissue soaked in alcohol.) The first mark goes dead center on top of the fuse just behind the wing saddle. The second mark goes dead center just ahead of the stab platform — on top of the fuse if the stab sits on top, or beneath it if the stab sits below the fuselage. Draw the third mark on the stab itself, dead center at the leading edge (see Fig. 6-5).

Once you've made the alignment marks, pin the stab firmly in place so that the center mark on the stab aligns with the center mark just ahead of the stab platform. Measure from each stab tip to the workbench as shown in Fig. 6-6. Both measurements should be the same. If they're different, remove the stab and carefully sand the platform. Be careful not to remove too much wood, round the platform, or change the angle at which the stab will meet the air in flight. Pin the stab back in place and repeat the measurements. If need be, repeat the whole operation until you get it right.

With the stab pinned in place and level, use your tape measure to measure from the alignment mark behind the wing saddle to each rear corner of the stab as shown in Fig. 6-7. If the measurements are not the same, reposition the stab and measure again. When you've got it right, check to be sure that the tips are still the same distance from the bench.

If the stab sits on top of the fuselage, turn the plane over and use a ballpoint pen to draw lines on the underside of the stab where it meets the fuselage on the left and right (see Fig. 6-8). If the stab fits beneath the fuselage, leave it in place and draw the lines on the top where it meets the fuselage.

Take away the stab and draw a second set of lines (see Fig. 6-9). Cut the covering along the inner set of lines without cutting the wood beneath it and strip off the center section of covering material.

Smear the stab platform and the

Fig. 6-9. The second set of lines should be parallel to and 1/16" inside the first.

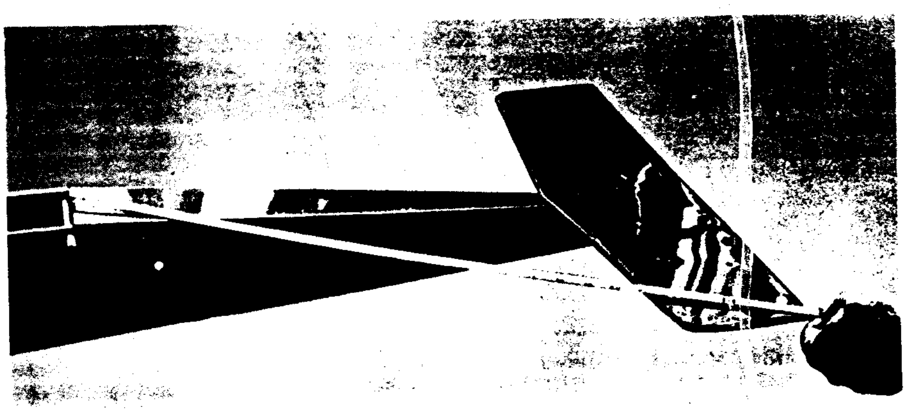


Fig. 6-7. The distance from the alignment mark behind the wing saddle to each rear stab tip should be the same.

Fig. 6-8. Mark the stab on the left and right sides where it meets the fuselage.

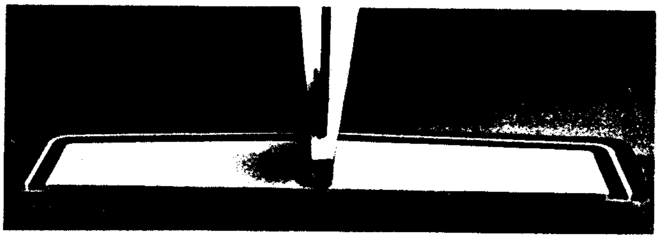


Fig 6-10. If the stab sits crooked in its slot, sand or cut down the high side to level it.

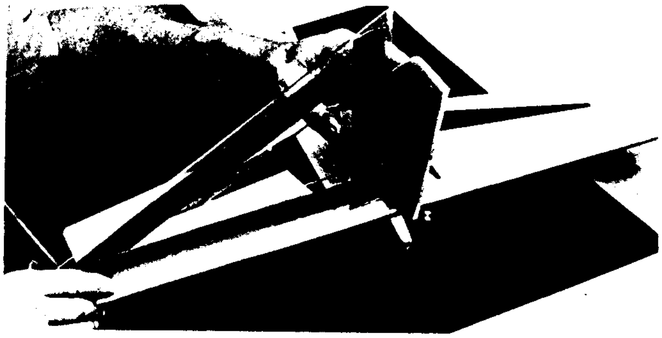


Fig. 6-11. A drafting triangle or a carpenter's square will help get the fin vertical.

FIG. 6-12 SQUARING FIN WITH STABILIZER

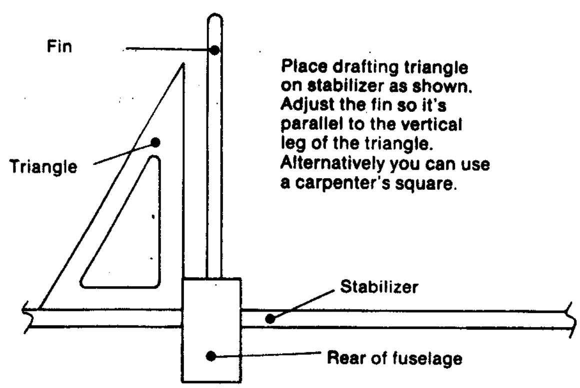
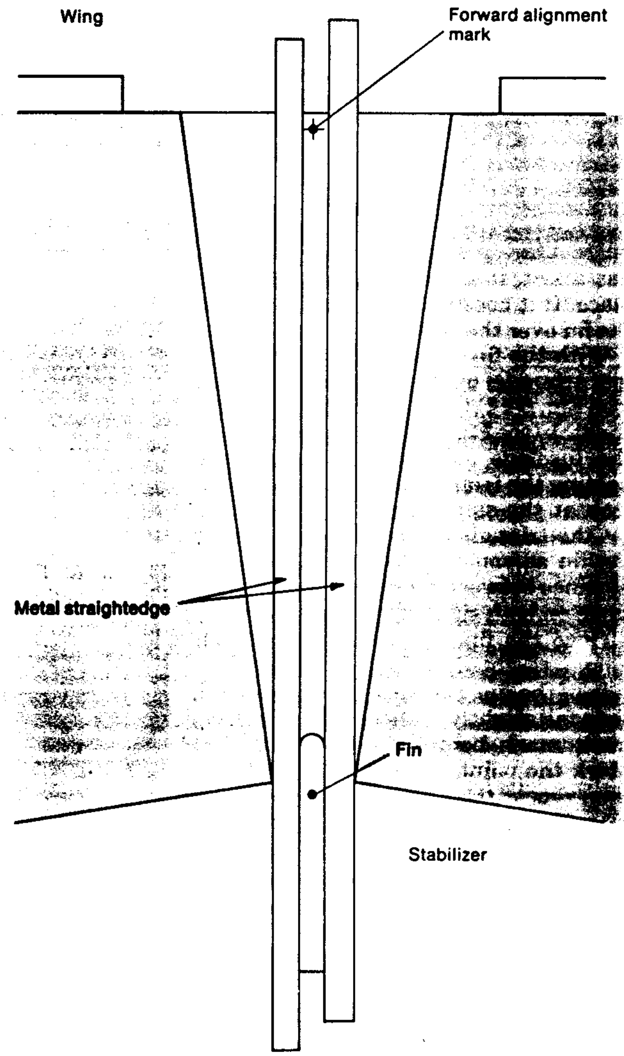


FIG. 6-13 ALIGNING THE FIN

A straightedge placed flat against the left side of the fin should miss the forward alignment mark by the same amount as a straightedge placed against the right side of the fin.



newly exposed wood on the stab with 30-minute epoxy, then use several pins to attach the stab to the platform so the center line is even with the mark ahead of the stab and the lines on the stab are flush with the fuselage on both sides.

Wipe off excess epoxy with an alcohol-soaked tissue. Measure one last time to be sure the stab is still aligned and level. If there's a problem, make adjustments before the epoxy cures. Set the work aside while the glue dries.

ARF Models

This procedure is slightly different from the one used on other planes because the stabs on the ARFs covered here fit into slots rather than on top of platforms.

If necessary, cut out the slot, then slip the stab into it and measure to be sure the length is the same on each side. If it's not, adjust until it is. Then measure to be sure both tips are the same distance from the workbench (see Fig. 6-10). Sanding or cutting the high side of the stab to even it will leave a gap at the top side of the slot that you'll later have to fill with epoxy and balsa.

Make a mark with a ballpoint pen dead center on the top of the fuselage behind the wing saddle (see Fig. 6-5). You can erase the mark later with a tissue soaked in alcohol. Measure from the mark to each rear corner of the stab; the measurements should be the same (see Fig. 6-7). If they aren't, adjust until they are. When you've done this, pin the stab securely in place and draw lines on the top and bottom on both sides of the stab where it meets the fuselage.

Remove the stab and draw a second set of lines parallel to and 1/16" inside the first sets. Cut the covering along the inner lines without cutting the wood beneath, then peel off the center covering section to expose the wood.

Smear 30-minute epoxy into the slot, being sure to cover every bit of wood, then smear epoxy over both the top and bottom of the exposed wood on the stab. Slip the stab into position and repeat your measurements to be sure it's level and lined up with the mark behind the wing saddle. If it's not, adjust, then pin it in place, wipe off excess epoxy with an alcohol-soaked tissue, and check your measurements one more time. Allow the epoxy to cure, then fill any gap between the stabilizer and fuselage with epoxy, or if it's a large gap, with wood and epoxy.

FIN INSTALLATION

The critical part of installing the fin is getting it lined up perfectly with the fuselage center line. If you miss, the

lane may be impossible to trim for straight and level flight under varying speed conditions, so extra effort is in order. It's also important that the fin rest upright on top of the fuselage, though not as important as getting it lined up on the center.

Before you start, make sure you can locate any fin braces and that you've already covered the parts of the braces that will be exposed after the braces are installed. Most trainers have a precut slot for the fin, but it's not always accurately aligned. If yours is off a little, you'll have to trim it to allow the fin to line up properly. If your plane has a slot, insert the fin and pin it in place. If it doesn't have a slot, just pin the fin over the stab center line.

With the fin in position, use a drafting triangle or a carpenter's square (see Fig. 6-11) to set it at a 90° angle to the stab (see Fig. 6-12). On some planes the fuselage sides prevent you from holding the triangle against the fin and stab at the same time. In such cases, set the triangle on the stab as close to the fin as you can and make sure the distance between triangle and fin is the same on both sides of the airplane.

Once the fin is vertical, place your long straightedge flat along the left side of the fin. The straightedge should then fall slightly to the left of the alignment mark behind the wing saddle. Mark the point as shown in Fig. 6-13, then repeat the procedure on the right side. You should now have a mark on either side of the alignment mark and the distance between the alignment mark and each other mark should be the same. If it's not, adjust the fin and repeat the measurements until it is, trimming the slot if necessary to accomplish this.

PREPARING TO GLUE THE FIN IN PLACE

Once the fin is aligned and pinned in place, you need to draw lines to guide you in removing covering so you'll get a good wood-to-wood glue joint (see Fig. 6-14). If your fin fits into a slot and doesn't have a brace, mark the fin and dorsal fin, if any, where they meet the fuselage and/or stab. Now mark the fuselage where it meets the fin and dorsal fin. If your fin has no slot, just mark the stab and fuselage top where they meet the fin. If your fin has braces, pin them in place and outline them on the stab and fin.

Remove the fin and cut the covering material on the fin, stab, and airplane fuselage top about 1/16" inside the outermost line you drew. Don't cut the wood below. Now strip off the covering material inside the cuts.

Cover all exposed wood parts on the fin, dorsal fin, slot, stab, and braces with 30-minute epoxy, pin the fin back into position, and add the braces. Then get your straightedge and triangle (or

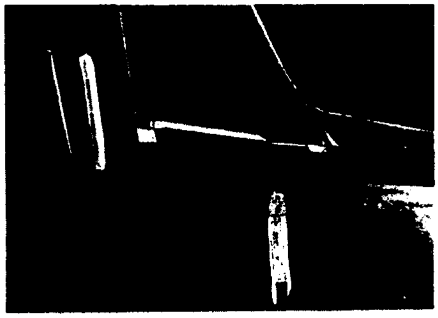


Fig. 6-14. Mark areas of wood-to-wood contact and strip off enough covering to allow good glue joints.

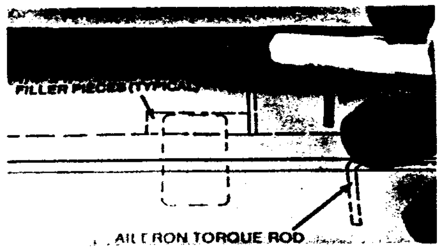


Fig. 6-16. For conventional kits, mark hinge locations over the plans.

Fig. 6-18. Here is how to insert the hinges into the slots.

carpenter's square) and adjust until the fin is perfectly aligned with the center mark behind the wing saddle and sits perpendicular to the stab. Once you've got it right, leave the assembly alone overnight until the epoxy's cured.

INSTALLING HINGES ON FIN, STAB, AND WING

Start by drawing center lines on the trailing edges of the wing, stab, and fin, preferably using a Goldberg scriber (see Fig. 6-15). Next, mark the location of each hinge with a ballpoint pen. You can erase the marks after the hinges have been installed. Take the hinge locations from the full-size plans if your kit supplies them (see Fig. 6-16). It's important to get the hinges in just the right places, especially if your plane's wing contains filler blocks designed to give the hinge more wood to hang on to. If your plane is an ARF with precut slots or holes, don't use them. Instead, make new slots a little to one side of them.

Fig. 6-15. A Goldberg scriber helps you draw good center lines. I used a bare piece of wood to demonstrate the technique because the camera didn't see it well on covering material, but the technique's the same.

Fig. 6-17. The hinge slot should be a little deeper than half the hinge length and half again as long as the hinge is wide.

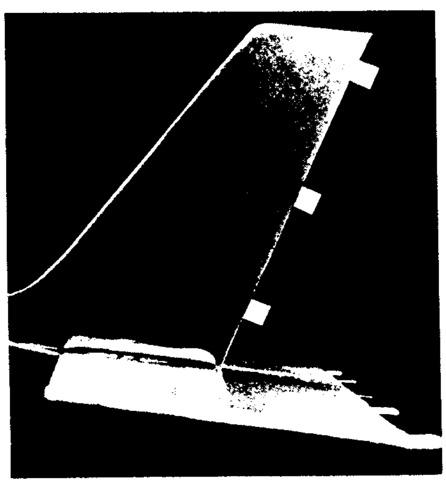


Fig. 6-19. Here are the hinges glued in place. Use only the thinnest, most irritating kind of CA glue.

Having located a hinge position, simply cut a slot with your modeling knife as shown in Fig. 6-17. When you've cut all the slots, insert a hinge halfway into each one as shown in Fig. 6-18, and put a drop or two of thin CA glue on each side of the hinge at the slot. Do not use thick CA or thin User Friendly Odorless "Hot Stuff" for this job. They don't penetrate deep enough (see Fig. 6-19).

Make sure none of the CA leaks out

Fig. 6-21. Gluing the hinges. Be careful not to let the CA run out onto the covering.

Fig. 6-22. Sop up extra glue with a dry tissue.

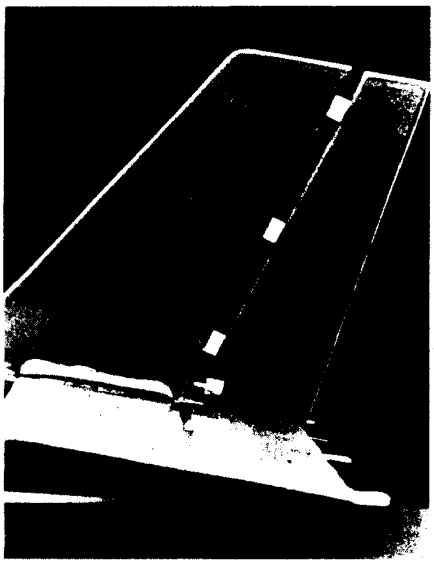


Fig. 6-20. Slide the control surface over the hinges. On this plane I glued the rudder in place first. On some planes, if you do this, you won't be able to get the elevator on. Test fit the surfaces on your plane before you start gluing.

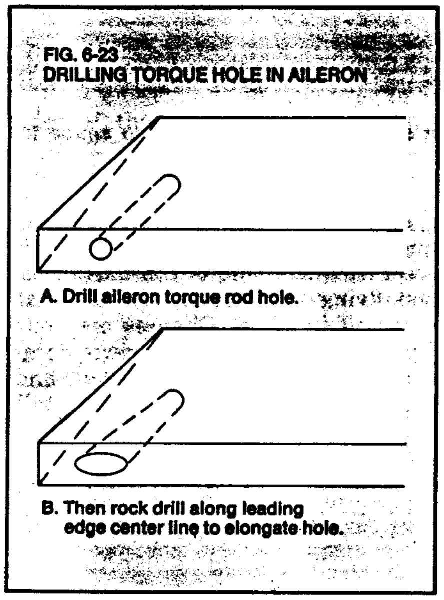
onto the main surface. The stuff loves to run across a wing or tail and make a permanent mess. Sop up any excess with a dry facial tissue. Use capillary action; don't rub the tissue around, and don't let it get glued to the plane.

HINGING THE CONTROL SURFACES

Cut slots in the rudder, elevator, and ailerons. These slots should be about twice as wide as the hinges so you can move the control surface back and forth to line it up properly. Install the elevator first. (On some planes if you do the rudder first, you can't get the elevator on.) Do the ailerons last after you have experience because they're a bit more complicated.

HINGING ELEVATOR AND RUDDER

Slip the control surface over the hinges you've already glued in place and align everything (see Fig. 6-20).



Move the control surface 45° in both directions to check the hinge gap. You want only enough gap to allow this plus or minus 45° movement.

Hold the surface at the 45° position and apply a drop of thin CA to the exposed side of each hinge as shown in Fig. 6-21. Remove the excess with a tissue as shown in Fig. 6-22. Finally, turn the work over, bend the control surface 45° the other way, and repeat the CA application on the second side. That's all there is to hinging the elevator and rudder.

HINGING THE AILERON

The complication with ailerons is that while you're hinging them, you also have to epoxy the torque rods in place. Before you do any gluing, enlarge the aileron torque rod holes as shown in Fig. 6-23, then test fit the aileron over its hinges and torque rod to be sure everything slips easily into place. Mix a batch of 30-minute epoxy. Do only one aileron at a time, and DON'T USE FASTER EPOXY!

Use a pin to drive epoxy into the torque rod hole. You'll probably have to do this two or three times to get all the bubbles out and fill the hole completely. Once you've done that, slip the aileron over the hinges and torque rod. Use an alcohol-soaked tissue to clean off excess epoxy.

Make sure you can move the aileron 45° in either direction, then glue the hinges as you did with the elevator and rudder. When you've done this, again clean up any epoxy, then set the wing aside while the epoxy cures completely. Finally, check the control surface to be sure you can still obtain 45° movement either way. While you're at it, tug hard on the control surface, just to be sure you can't pull anything loose.

PREPARING THE WING SADDLE

Widening the saddle: Some planes' wing saddles aren't wide enough to accept seating tape. If yours is narrower than 1/4", glue 1/4"-square balsa to the inside of the saddle on each side of the fuselage (see Fig. 6-24).

Leveling the wing: Place the wing on the saddle and hold it down with a couple of rubber bands. Make sure it's centered, then measure from each wing tip to the workbench. If the measurements differ by more than 1/4", sand the high side of the saddle and check again. Be careful not to take off too much wood on the first try. If the saddle is way off, you may have to shim the low side with 3/32" balsa, then sand until the wing is level.

Installing the wheels: This step is often more of a nuisance than you'd expect because the wheels sometimes don't fit over their axles. If you have this problem, file any burrs off the axles. After that the wheels probably will go on but still won't turn freely, so the next step is to drill out the hubs. If your landing gear is 5/32" wire, use a 5/32" drill, not a larger one. If it's a 1/8" wire, as it is on most smaller planes, use a 1/8" drill.

You can work out your own technique for drilling the holes, but here's mine, which can be a little risky. I insert the drill through the hub, then while holding the wheel, I turn on the drill and rock the wheel a couple of

Fig. 6-24. Widening the wing saddle to accept seating tape. You'll have to shape the square balsa to make it fit on some airplanes.

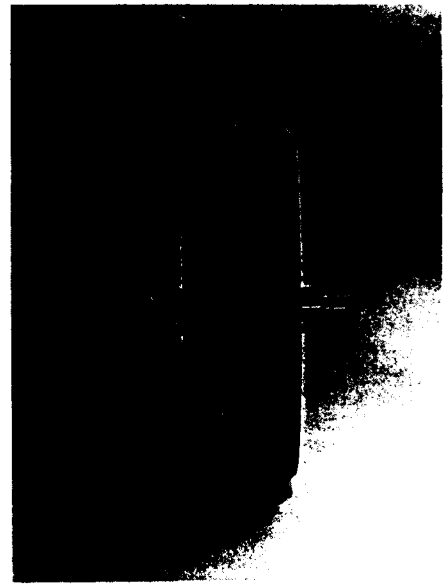


Fig. 6-25. Wherever possible put a wheel collar on both sides of the wheel.

times while I drill, then give the wheel a quarter turn and drill and rock again. I repeat this for a full revolution of the wheel, then check to see if it fits. If it doesn't, I repeat the procedure until it does.

Once the wheel fits the axle and turns freely, take it off, install a wheel collar on the inside of the axle, replace the wheel, and install the outside wheel collar. Tighten the collars as much as you can with your hex wrench (see Fig. 6-25). One of the most common flying mishaps is a wheel that comes off in flight. Chances are your plane will land without serious damage, but if you can't find the wheel and its collar in 40 acres of woods or tall grass, you can't fly until you buy new ones.

One minor problem: At least one of the planes covered here has main gear axles too short to accept the wheel and two collars, so you'll have to make do with one collar on each of these. However, even on that plane, you need two collars on the nose gear.

That completes the post-covering assembly. You can now begin to install the radio system for keeps.

7. Final radio installation

The plane looks like a plane now and the main thing keeping it from flying is that radio still sitting on the bench. A few hours of work will take care of that, but don't rush it.

AILERON SERVO INSTALLATION

Start by installing the aileron servo. THE MANUAL shows you how everybody else does it, but I'll describe a quicker way that's more secure and provides better vibration protection.

Cut a hole in the bottom of the wing just aft of the main spar as shown in Fig. 7-1. Don't forget to leave 1/8" of the rib to support the top sheeting, or on planes with no top sheeting, to support the covering material.

The easiest way to cut out the center rib is brutal. Figure 7-2 shows how. You'll shortly have a jagged hole. Clean it up with your modeling knife, and test fit the servo to be sure it doesn't touch wood at any point except the bottom, where it will be cushioned by foam rubber.

Now cut 1/4"- or 5/16"-square balsa rails to support the bottom sheeting on three sides as shown in Fig. 7-3. Glue the rails to the sheeting and sand them flat. Next, attach a square of 1/4"-thick foam rubber to the bottom of the servo with silicone glue. Smear silicone glue over the tops and insides of the rails, but not on the end without a rail because that's where the servo lead exits. If you glue the lead, it will be difficult to remove the servo without damaging it. Now smear silicone glue over three sides of the servo case at the level where it will meet the rails as shown in Fig. 7-4. Also put a dab of glue on the foam rubber underneath, then insert the servo into the wing. Smooth out the glue around the servo, then check to see that the servo case doesn't touch the wing, and set the assembly aside to cure (see Fig. 7-5). If you ever need to remove the servo, cut it out with your modeling knife.

IN-FUSELAGE SERVO AND PUSHROD INSTALLATION

While the glue cures on the aileron servo, you can work on the fuselage. Re-install the three servos in the fuselage, then slip the elevator and rudder pushrods into position and install the clevises on their threaded ends. Temporarily hook up the Rx, servos, switch harness, and battery. Turn on the Rx and Tx and center the rudder, elevator, and aileron trim tabs. Set the throttle stick and trim tab to the half-open position.

If the elevator pushrod exits through the open end of the fuselage, remove the clevis, slip a clevis keeper over the metal rod, then screw the clevis back in place (see Figs. 7-6 and 7-7). If the pushrod exits through a slot, omit this step. If a keeper were to come loose and lodge in a slot, it could interfere with control movement.

With the clevis in, fasten the elevator pushrod, rudder pushrod, steering cable, and throttle cable to their servo arms and put the rudder and elevator arms on the servos in their neutral positions. Install the throttle arm on its

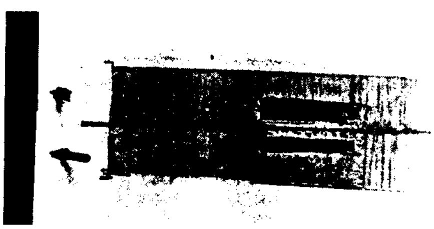


Fig. 7-1. The hole in the bottom of the wing should be wide enough to clear the servo by 1/16" on each side, long enough to allow the servo lead at least 3/8" clearance, and deep enough that it leaves 1/8" of the center rib under the top.

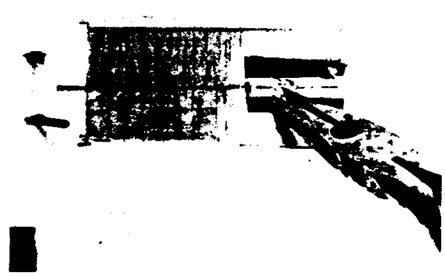


Fig. 7-2. Grab the rib with needlenose pliers and twist it.

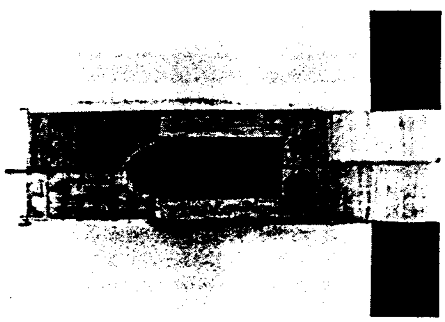


Fig. 7-3: The supporting rails should be 1/4"- or 5/16"-square balsa.

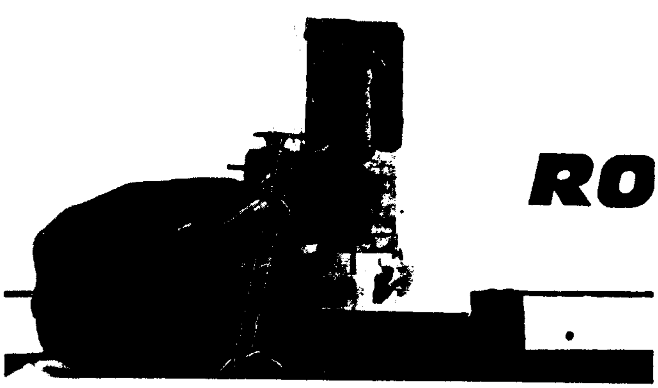
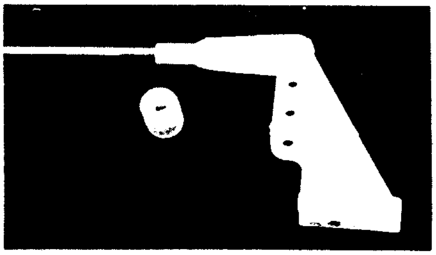
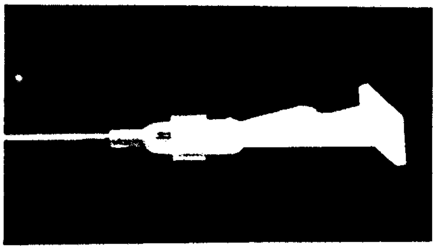


Fig. 7-4. Do not smear any silicone glue on the end of the servo case where the lead is.

Fig. 7-5. The aileron servo in place.





Figs. 7-6 and 7-7. The clevis keeper is just a slice of silicone fuel line that helps prevent the clevis from popping open.

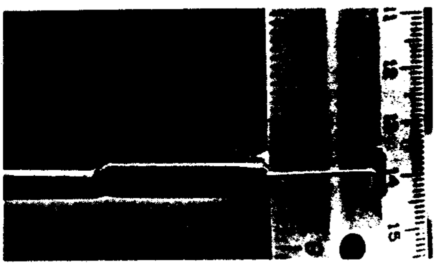


Fig. 7-8. A pin stuck in the trailing edge of the control surface allows you to measure control throw accurately.

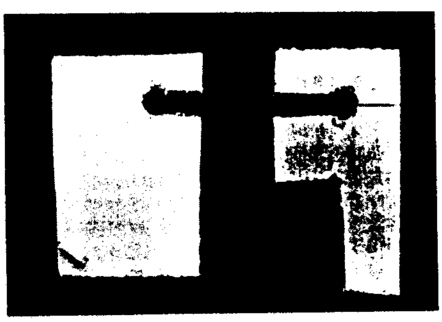
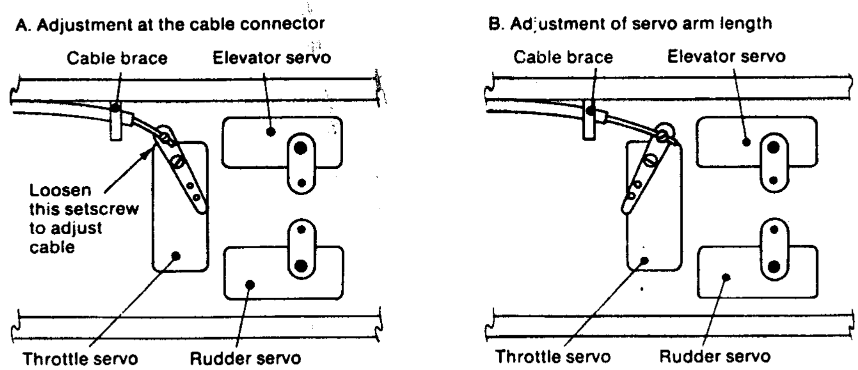


Fig. 7-9. Cut cable braces from scrap plywood or balsa.

Fig. 7-10. The completed installation should look something like this.

FIG. 7-11 THROTTLE ADJUSTMENTS AT THE SERVO END



With the servo pushing the cable as far forward as possible (stick and trim tab in fully open position), the carburetor barrel should be wide open and the servo shouldn't be stalled. To achieve this condition, loosen the pushrod connector setscrew and allow the cable to seek its own position. Be sure the carburetor barrel stays open while you do this. Once you've got the right arrangement, re-tighten the setscrew.

With the throttle stick and trim tab in the fully closed positions, the carburetor barrel should be completely, but just barely, closed. If the barrel is still open, you need to increase the length of the adjustable servo arm, then repeat the adjustment at the cable connector with the throttle stick and trim tab fully open. Then close both stick and trim tab again to see if the carburetor barrel closes properly. If the barrel closes before you completely close the stick and trim tab, you need to shorten the arm, readjust at the cable connector, and try again. It takes some fiddling, but be sure to get it right.

servo in the position that's halfway.

Temporarily connect the rudder and elevator clevises to their control horns to see how close to neutral those surfaces are. Adjust the clevises until both are exactly neutral.

Loosen the steering cable setscrew at the servo and set the nosewheel to its neutral position, then tighten the setscrew. Adjust the throttle cable the same as you did in the preliminary radio installation.

Consult the chapter on your kit for the control throws recommended for your airplane. Measure the throw first on the rudder, then on the elevator (see Fig. 7-8). Adjust by moving the clevis from one hole in the horn to another. In general, it's best to be as far out as possible on both the servo arm and the control horn. This minimizes slop, reducing the likelihood of control surface flutter. The elevator throw should be at least the specified value.

If you have to be off a hair, be sure you have slightly more throw than called for. If you have too little throw, you may not be able to flare the plane for landing. Rudder throw isn't as critical, but should be approximately the amount specified.

If you're using an elevator clevis keeper, now is the time to slip it over the clevis. To provide yourself with a little working room, give a full elevator command to push the clevis out of the fuselage, then turn off the Rx and slide the keeper in place. Turn the Rx back on to neutralize the control surface, then switch off both the Rx and Tx.

The next step is to install throttle and steering cable braces. Usually I just cut pieces of plywood or balsa scrap as shown in Fig. 7-9 and epoxy them in place near the servo ends of the nylon cable tubings. Be careful not to get epoxy on the servos, servo leads, servo tray, or Rx (see Fig. 7-10).

Most of the time one brace per cable is enough, but test the control after the epoxy cures. If the cable bends a lot under pressure, glue a second brace to it just before it disappears into the fuel tank compartment.

With the cables braced, you can make final adjustments to the steering and throttle controls. This is easy for the steering cable. Loosen the setscrew on the steering servo arm (rudder servo). Turn on the Rx and Tx and make sure that the rudder trim tab is

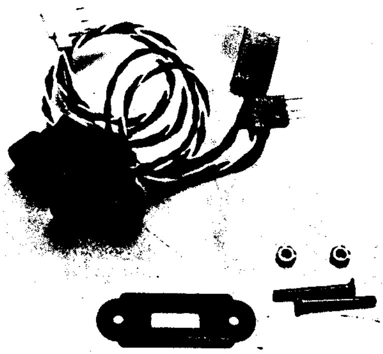


Fig. 7-12. The switch harness.

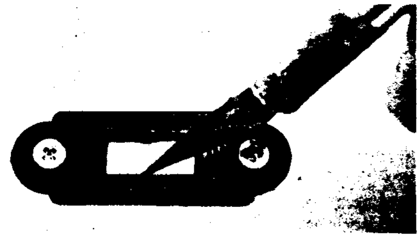


Fig. 7-13. Tape the switch plate to the side of the fuselage, drill two 1/16" screw holes, install the screws, then mark the switch cutout with your modeling knife.

Fig. 7-14. The installation of the switch should be made from the inside.

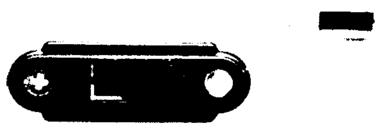


Fig. 7-15. Switch and charge jack as viewed from the outside.

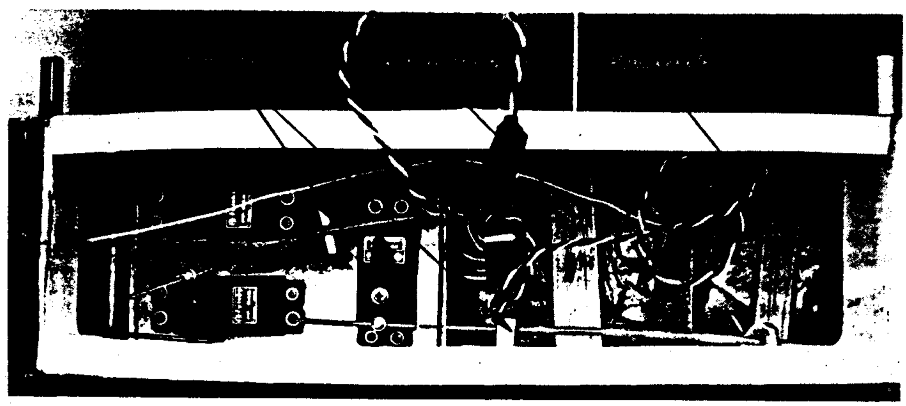


Fig. 7-16. Glue balsa braces over the receiver and battery to prevent moving.

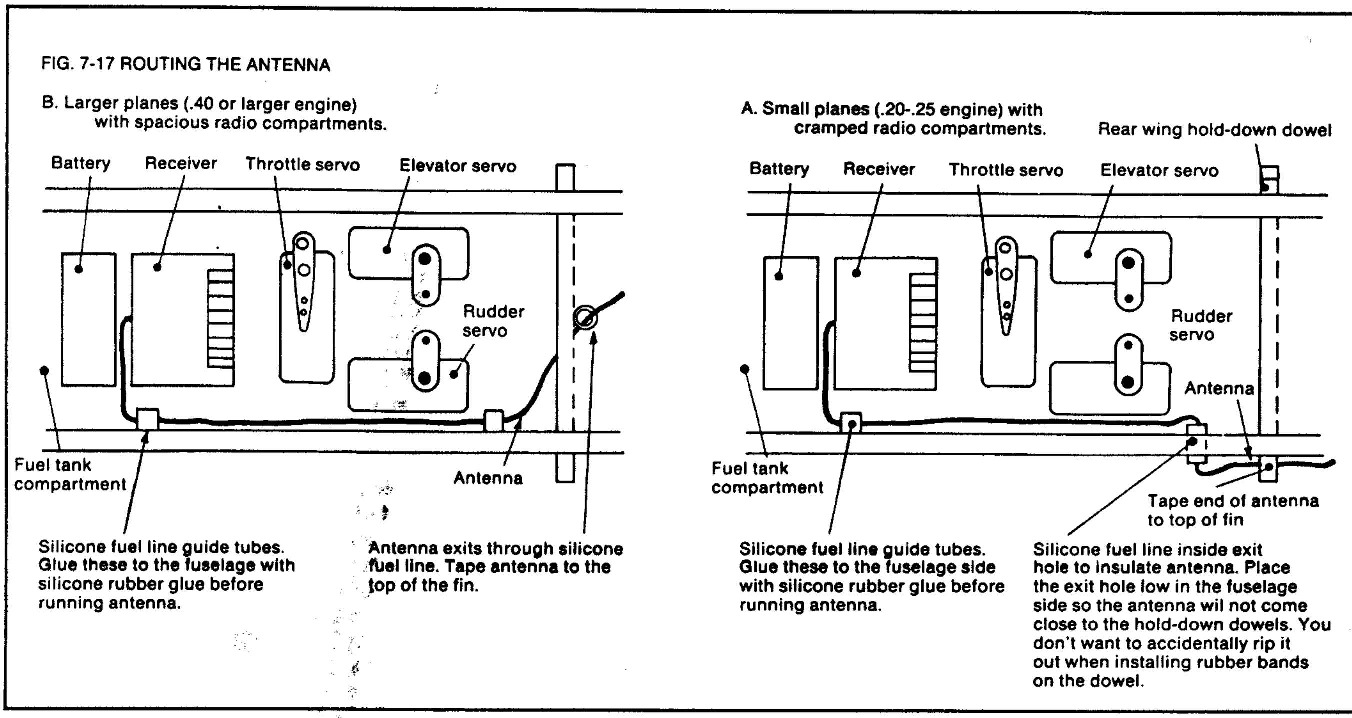


FIG. 7-17 ROUTING THE ANTENNA

centered. Adjust the nosewheel so it points straight ahead, then tighten the setscrew. With the radio still on, set the plane down on a flat surface (I use a road in front of my house) and give it a shove. If it turns right or left, make the necessary adjustment at the servo cable connector and try again. When you've got it right, tighten the setscrew firmly, take the plane inside, and start on the throttle adjustment.

Loosen the setscrew on the pushrod connector on the adjustable arm, then manually pull the throttle arm on the carburetor to the fully open position. The cable should slide through the connector without resistance. Now move both the throttle stick and trim tab to the fully open positions and tighten the setscrew. Gently move the throttle stick toward the closed position, backing off if you encounter resistance. If you do, shorten the adjustable arm and start over. If you don't get any resistance, close the stick all the way, then close the trim all the way. If the barrel is still open, lengthen the adjustable arm slightly and try again. Keep fiddling until the barrel is slightly open with the trim tab open and the stick closed and the barrel is completely, but just barely, closed when you close both stick and trim tab. Then check to be sure that when you open the stick and trim tab all the way the barrel is wide open. Make sure the setscrew is tight-

ened firmly, then turn off the Rx and Tx (see Fig. 7-11).

SWITCH AND CHARGE JACK INSTALLATION

The switch and charge jack (see Fig. 7-12) go on the side of the fuselage opposite the muffler where exhaust oil won't get on them. Put them out of the way of the servo arms and cable braces and where they won't interfere with installing the Rx and battery.

Having chosen the location, mark the outline of the charge jack on the outside of the fuselage. If your system uses Futaba connectors, orient the jack so the side with the raised line faces the rear of the plane. This will make it easier to fit the charge plug into the jack. Now cut the hole for the jack, making it a tad too small. You'll enlarge it later.

Tape the switch's on/off plate to the outside of the fuselage and use it as a guide to drill two holes. Slip the hold-down screws through the plate and holes and mark the cutout for the switch itself on the covering with the point of your modeling knife (see Fig. 7-13). Remove the switch plate and cut out the switch hole, making it slightly oversize in every direction. If the switch is not free to move to its limits, engine vibration could shut it off in flight! Test fit the switch from the inside of the fuselage, and if all is well, replace the plate and screw the switch in place (see Fig. 7-14). Tighten the screws firmly, but not enough to crush the wood.

Cautiously enlarge the hole you made for the charge jack until you can just insert the jack. It should protrude 1/8" to 1/4" outside the fuselage. Glue the jack in place from the inside with slow CA and accelerator. Then glue the outside, making sure you don't get glue into the jack. If you do, you'll have to replace the switch harness (see Fig. 7-15).

BATTERY AND RX INSTALLATION

With the switch harness in, you can permanently install the battery and Rx. Place them so you can get at the Rx because you'll need to check the servo leads before each flying session.

On the planes built for this book I glued the Rx and battery in place with silicone glue, then braced them with pieces of 1/4" balsa as shown in Fig. 7-16. After the last plane was done, a club member showed me what looks like a better way. Glue Velcro, business-side down, to the fuselage floor where you want the Rx or battery to be. Place the Rx or battery over the Velcro, then secure it with a second strip of Velcro. This installation is lighter and allows you to remove components on a whim. I haven't tried it yet, but it worked well in his plane.

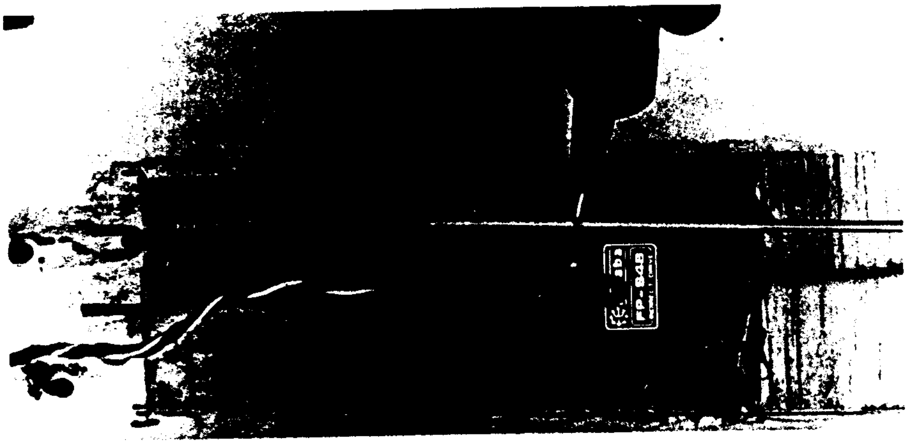


Fig. 7-18. Marking the aileron pushrods.

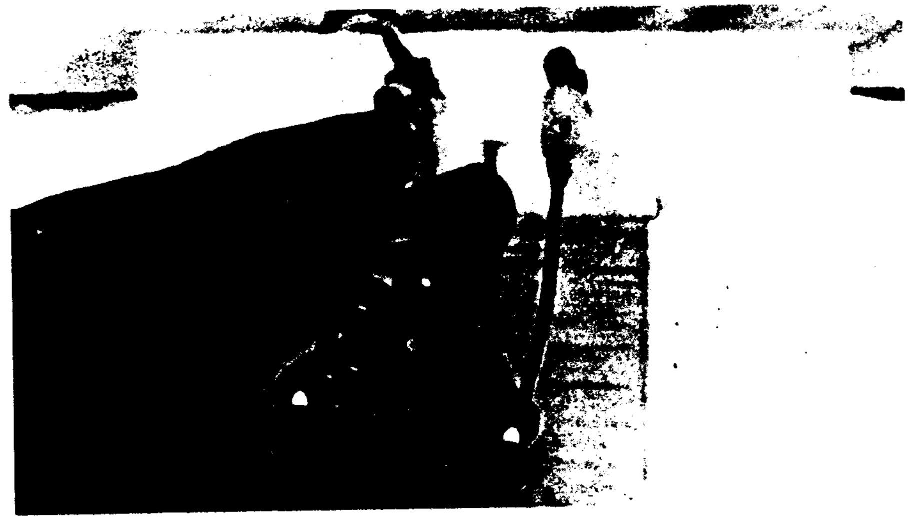


Fig. 7-19. Slip the aileron servo arms over the Z-bends of both pushrods.

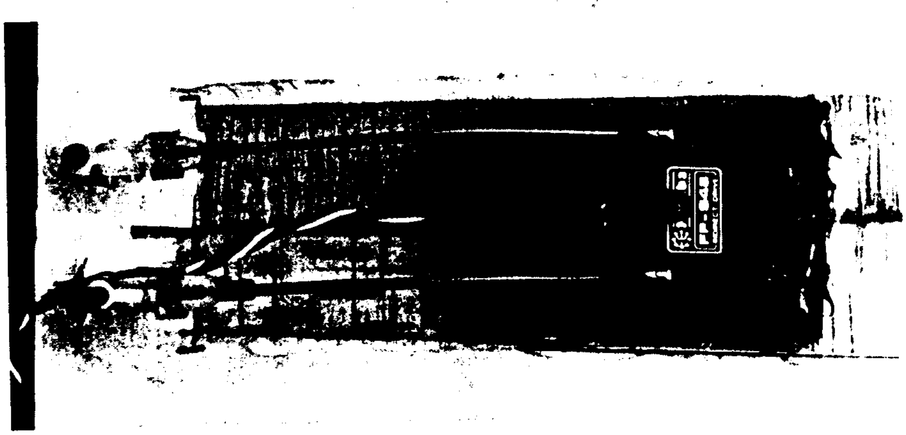


Fig. 7-20. Attach the arm to its servo, adjust the clevises, then slip the clevis keepers into their positions.

ANTENNA INSTALLATION

You'll want the antenna to exit without touching anything solid, so don't jam it against the battery or a piece of wood.

Now you have to decide how to run the antenna out of the plane. Figure 7-17 shows a couple of options. On smaller planes I usually run it out the left side (away from the exhaust) well below the rear wing hold-down dowel, and attach it to the top of the fin. On larger planes, I run it out the top of the fuselage just behind the wing saddle.

The antenna must follow as straight a course as possible and be guided through pieces of fuel tubing glued to the side with silicone rubber glue. Choose your path to keep the antenna

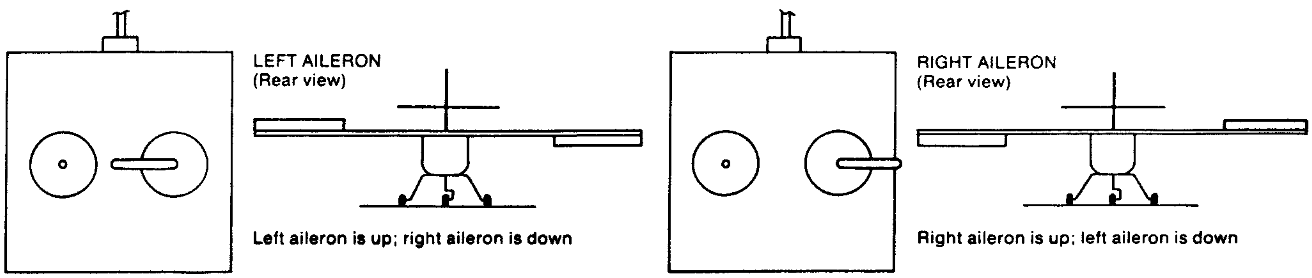


FIG. 7-21 TRANSMITTER COMMANDS AND AILERON RESPONSES

This is the most important hookup on the airplane. Get it reversed and anybody can take it off, but nobody can fly it. Planes with reversed aileron throw never fly for more than a couple of seconds.

as far as possible from other electronic components.

Although there are several common ways to attach the antenna to the fin, all put the tension of a rubber band on the antenna, which could conceivably pull something loose. To minimize that possibility, I just use a piece of cellophane tape to attach the antenna to the fin, making sure not to quite pull it tight when I stick it down. No matter how you attach the antenna, there'll be a bit of "excess" hanging down. LET IT DANGLE. If you cut it, you'll detune the receiver!

INSTALLING THE AILERON PUSHRODS

Tape the ailerons in their neutral positions, then connect the aileron servo lead to the Rx and turn on the Rx and Tx. Center the aileron trim tab and check to see that the servo arms are positioned as shown in the plans or THE MANUAL.

Install a clevis on a threaded pushrod and connect it to the torque rod horn. Run the rod over the spot where it will attach to the servo arm and mark it at the servo arm hole with a fine-tip felt pen (see Fig. 7-18). Make a Z-bend at the mark. (See Fig. 4-57.) Duplicate this procedure for the other aileron pushrod, then remove the tape from the ailerons.

Remove the servo arm, ream it out to accept the rods, slip pushrod keepers over both pushrods (see Fig. 7-19), install the rods in the arm, and replace the arm on the servo (see Fig. 7-20). If the ailerons are not in their neutral positions, adjust them at the clevises.

Position the wing on its saddle and move the aileron stick on the Tx to the right. The right aileron should rise and the left one should go down. If it works the other way, flip the servo reverser switch and try again (see Fig. 7-21). Now check the chapter on your plane for the correct aileron throws and move the torque rod horns up or down to get the throw you need. If necessary, readjust the ailerons to their neutral positions with the clevises.

The radio installation is now complete and only a few important odds and ends remain before flight.

8. Final touches

With the radio installed, there are just a few operations to take care of before heading to the flying field.

WING SEATING TAPE

Cut two pieces of seating tape to fit the wing saddle and set them aside. I drill a series of 1/16" holes in the balsa part of the saddle (see Fig. 8-1). If your plane has see-through windows, make sure you do not inadvertently drill them. Apply a film of silicone glue over the entire saddle and use a pin to work glue into the holes (see Fig. 8-2). Remove the backing from one piece of seating tape and place it sticky side down on the saddle. Smooth it out and, if necessary, pin it in place. Repeat the procedure for the second piece of tape, and let the glue cure for a few hours. If your tape has two sticky sides, leave the protective covering on the second one for now. When you're about done working for the night, remove the covering to expose the second sticky side. Smear a thin layer of silicone glue over the tape and let it cure overnight. Next work session you can trim excess glue or tape with a razor blade.

COWL INSTALLATION

If your plane has a plastic cowl and/or fuel tank cover, install them now according to instructions in the chapter on your plane and in THE MANUAL.

MUFFLER INSTALLATION

If you just bolt the muffler in place, it will leak grease all over the engine compartment, so seal it with silicone rubber glue as shown in Figs. 8-3, 8-4, and 8-5. I used red glue because it's more photogenic, but most people use clear. When you've finished installing the muffler, connect the vent line from the fuel tank to the pressure fitting.

INSTALLING THE PROP AND SPINNER

If you're using a glass-filled nylon prop, sand off the sharp flashing before attempting to install it. Otherwise you could get a bad cut when you grip the prop to tighten the nut. You should also paint the tips white or yellow so you can see them when the engine's running. Many people have taken that ride to the hospital emergency room after putting their hand where they didn't see a prop.

The spinner backplate goes on the prop shaft first, followed by the prop, the washer, the nut, and the spinner. You may have to ream out the spinner backplate to get it on. I use needlenose pliers for this job (see Fig. 8-6). You also may have to ream out the prop (a Fox reamer is handy for this), and with some spinner/prop combinations you'll have to trim the spinner to clear the prop. Use your modeling knife and a measure of caution. (I've been known to stab myself.) Try to do all your trimming on the side opposite the pegs that snap the spinner in place.

If you ever intend to start the engine by hand (and by that I mean with a chicken stick, not a finger) you'll want

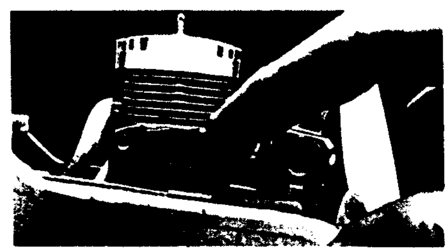


Fig. 8-3. Make a gasket by spreading silicone glue over the mating surfaces on the exhaust and muffler. Be careful that glue does not get into the engine and do not use so much that it squeezes in when you tighten the muffler.

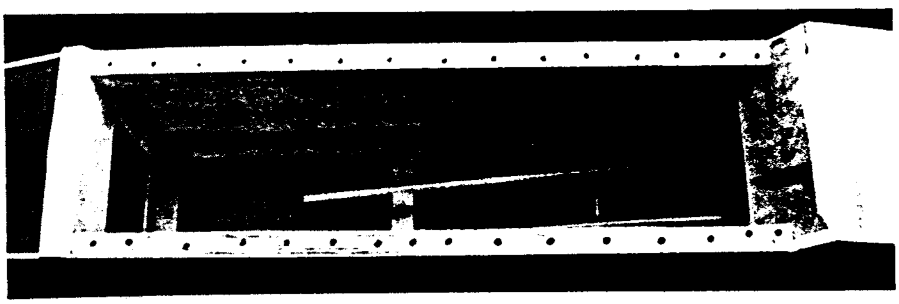


Fig. 8-1. Drill 1/16" holes in the wing saddle to attach the wing seating tape.

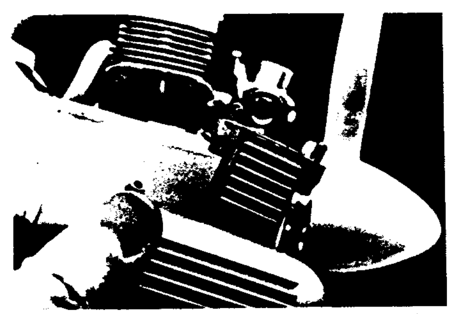


Fig. 8-4. Clean off excess glue from the mating surfaces.

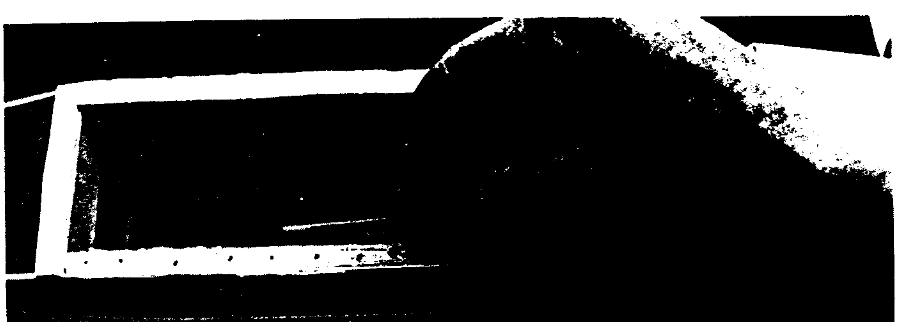


Fig. 8-2. Put silicone glue over the saddle and drive it into the holes with a pin. Then smooth the glue layer with your finger before laying the seating tape over it.

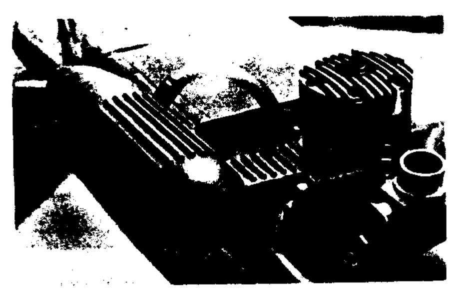


Fig. 8-5. Attach the tank's vent line to the muffler pressure tap.

to tighten the prop so that it is parallel to the ground at the beginning of the compression stroke. This gives you the best angle for flipping. If you plan to use an electric starter exclusively (not a bad idea) don't worry about prop position. Just snap the spinner in place and go on to the next task.

BALANCING THE PLANE

Find the recommended balance point in the chapter on your airplane and mark it in ballpoint pen on the underside of both wings.

Note: This is not necessarily the balance point given in THE MANUAL, but it is the one I've had the best luck with in test flights of the model. If you use a more forward balance point, you'll need more elevator throw and the plane won't fly as well. If you use a more rearward balance point you may need a bigger insurance policy. Tail-heavy planes can be unflyable, but they get into the air before you find that out.

Place your fingers on the balance lines you drew and hold the plane. If it sits level, it's already balanced. If the nose drops below the horizon, add weight to the tail. If the tail drops, add weight to the nose as far forward as you can get it. Don't fly before you get the balance right.

Anything dense that you can glue to the plane will serve as a balance weight. I've been known to epoxy quarters to the tail. Expensive? Not really. When the plane crashes or wears out, I spend the quarters. Most people use the stick-on weights available at hobby shops. When I use these, I slice off the sticky tape and epoxy the weights to the plane. Maybe I'm a worry wart. I've never seen a stick-on weight come off, but they make me nervous. If you epoxy a weight in place, cut away the covering where you intend to place it so the epoxy will have some wood to stick to, then dip the weight in epoxy to encapsulate it in the stuff before positioning it on the plane.

WING WARPS

If your plane is intended to have washout, skip this section and refer to THE MANUAL on how to do the washing. If you're building an ARF with a symmetrical airfoil, you can also skip this section. It's difficult to check symmetrical wings for warps, and ARFs are notoriously free of them. But if the wing is flat, check it out. A warped wing won't handle well in the air. A badly warped one won't even stay in the air.

If you have a flat bottom wing without washout, lay one panel on the building surface. It should lie flush at all points. If it's off by more than 1/8"

Fig. 8-6. Reaming the spinner backplate. Be careful not to overdo it.

Fig. 8-8. Now that you are finished building the plane, this book can assist you in learning how to fly it.

anywhere, you have to straighten it. To do this, twist the wing panel opposite the warp (it helps to have an assistant) and use your trim iron to heat the covering on both sides as you hold the twist. Remove the heat and hold the twist until the covering cools, then check to see if you've gotten rid of the warp. If not, repeat the heating and twisting until you have.

WING CENTER MARKINGS

On most trainers it's possible to place the wing a bit off-center and mess up the flight characteristics. To prevent this, all you have to do is iron alignment marks to the center of the wing's leading and trailing edges (measure; don't eyeball the centers) and to the center of the fuselage just ahead of and just behind the wing (see Fig. 8-7).

Congratulations! You've finished the plane. However, the engine needs a little tweaking and the prospective pilot needs a thorough understanding of what is required to fly these models. Most hobby shops stock LEARNING TO FLY RADIO CONTROL MODEL AIRPLANES (see Fig. 8-8), the book which covers those subjects in detail. I'm biased, having written that book, but tens of thousands of new RC pilots have cut their teeth on it and it seems to have helped.

Don't try to fly the plane on your own. You've put too much work into the plane to bust it up the first time out. Get help from a competent instructor for the first flight, and your plane should give you hours of enjoyment.

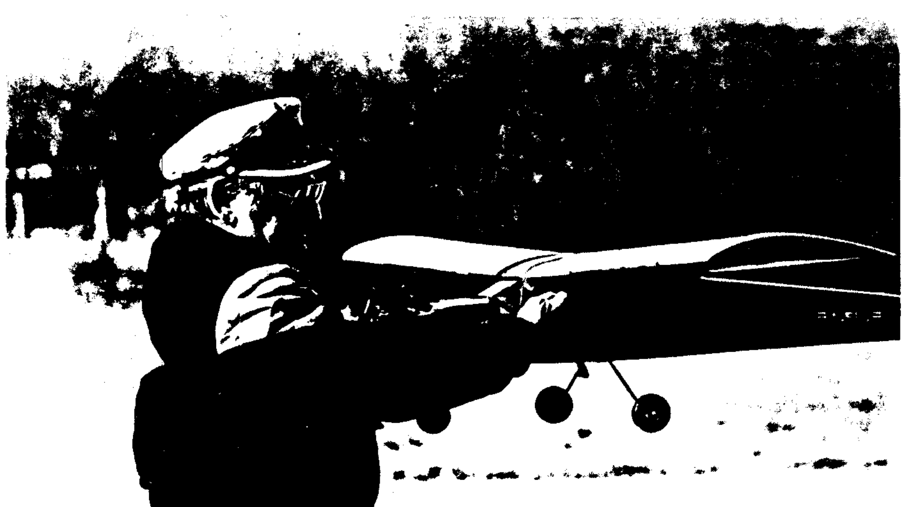
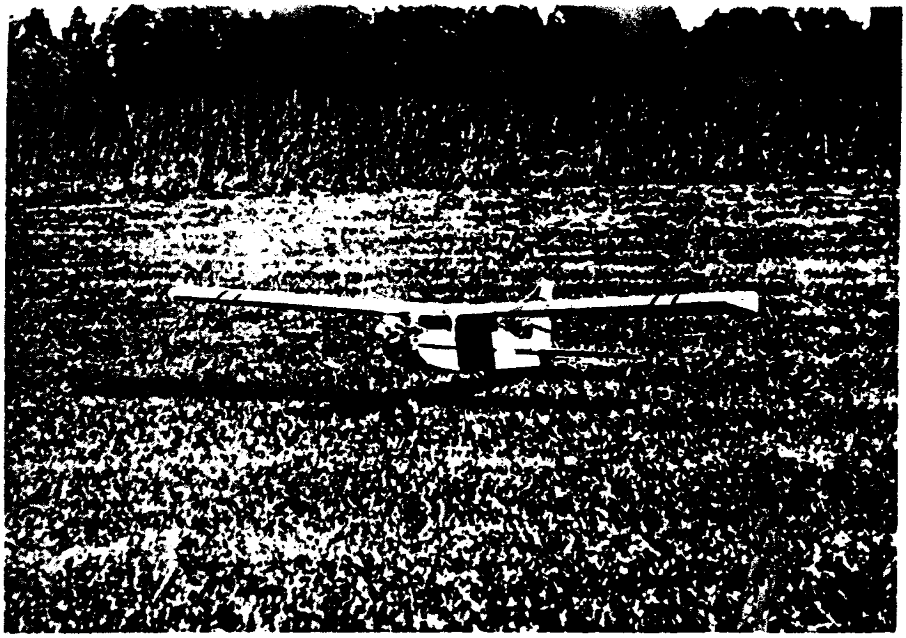
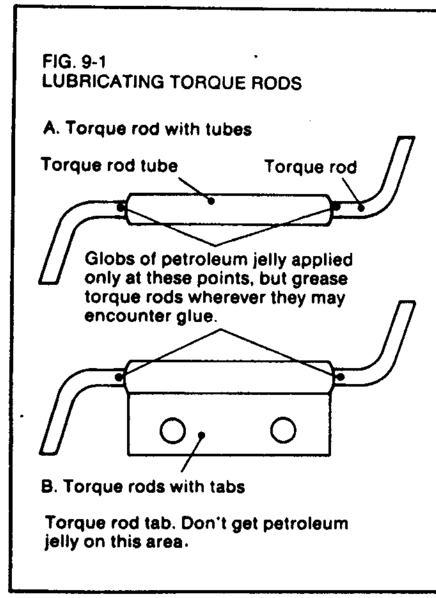


Fig. 8-7. Anexpert at the field shows how to balance a plane — just for show in this case because this Eagle has nearly 400 flights on it. When you balance your plane, do it indoors whee wind won't interfere.





9. Building the Goldberg Eagle 2, Eagle 63, and Eaglet 50

The remaining chapters provide specific instructions for building ten RC planes. The ones included are some of the best, and they're ideal for someone building his first RC plane. This chapter covers the Goldberg Eagle planes.

FRAMING THE MODEL

With the following exceptions, build the framework for the Goldberg Eagle planes as instructed in THE MANUAL.

The Wing and Tail

1) Be sure to sand all burrs from die-cut parts before gluing them. This gives you a better fit, which means a lighter, straighter, stronger model.

2) Wherever THE MANUAL says to mark or cut hinge slots, ignore it. You'll be using CA hinges, rather than kit hinges, and will do all marking and cutting after the model is covered, not now.

3) Dihedral joiners: Use epoxy rather than CA glue to attach dihedral joiners to the spars, and use C-clamps, rather than the plywood joiner clamps supplied with the kit, to hold these parts together while the glue dries. A sheet of waxed paper between clamp and wood will help you avoid gluing the dihedral joiners to the clamp.

4) Torque rods: The torque rods are those funny-shaped pieces of wire that connect the ailerons to the aileron pushrods. On the Eagle 2 they are held to the wing by a nylon tab. On the other Eagle planes they are held in place by a plastic tube. If you get glue between the torque rod and whatever holds it to the wing, the ailerons will never work smoothly. To avoid this possibility, smear a little petroleum jelly at the junctures of rod and tab (or rod and tube) before gluing anything in place (see Fig. 9-1). Be careful not to use more lubricant than necessary because it will prevent getting a good glue joint. THE MANUAL says to glue these parts with CA, but I suggest you use epoxy because CA glue can cut through the petroleum jelly and gum things up.

5) Connecting torque rods to ailerons: At some point you'll have to drill a hole in each aileron to accept the torque rod. First drill a hole as THE MANUAL says to, then rock the drill to elongate the hole as shown in Fig. 6-23, page 39. When you install the aileron, you'll fill this long hole with epoxy, providing a large bearing surface that will reduce the likelihood of vibration working the rod loose.

6) Aileron clearance: THE MANUAL suggests that you leave enough clearance at each end of the aileron to pass a matchbook cover. These gaps have a way of disappearing, so leave a little extra — about 1/8".

7) Mounting the aileron servo: Ignore THE MANUAL's instructions and don't cut holes or mount the servo until after the wing is covered. Then see Chapter Seven (Final Radio Installation) for the procedure.

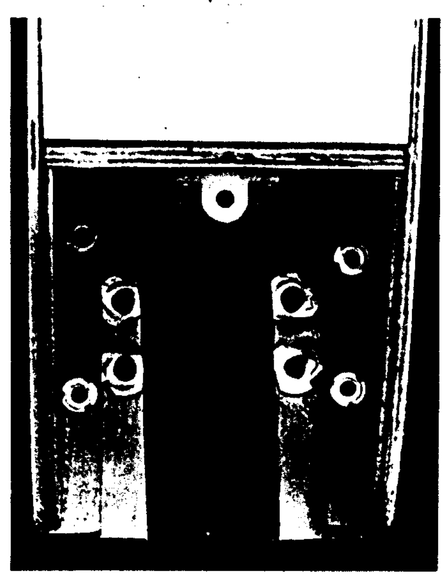


Fig. 9-2. Notice the gap between the fuselage bottom and the fire wall. You'll have to seal it with epoxy to prevent oil from getting into the fuselage.

The Fuselage

1) Deburring: Before beginning assembly, lightly sand all die-cut parts to remove burrs. If you don't, you can get weak joints and a crooked airplane that flies crooked. Don't glue anything until it fits perfectly.

2) Warped fuselage sides: In most Eagle and Eaglet kits I've seen, the light ply fuselage sides have been

SPECIFICATIONS FOR THE GOLDBERG EAGLE 2 AND EAGLE 63

Test Plane Specifications

Wingspan: 63"
Wing area: 715 square inches
Weight:
- Eagle 2: 84 ounces (5 pounds, 4 ounces)
- Eagle 63: 87 ounces (5 pounds, 7 ounces)

Wing loading:
- Eagle 2: 16.9 ounces per square foot
- Eagle 63: 17.5 ounces per square foot

Engine:
- Eagle 2: Royal .40 two-stroke
- Eagle 63: Royal .40 two-stroke

Radio:
- Eagle 2: Futaba Conquest 6-channel (4 used)
- Eagle 63: Futaba Conquest 4-channel

Propeller:
- Eagle 2: 10/6 Master Airscrew
- Eagle 63: 10/6 Zinger

Setup Recommendations

Controls: 4 channels — elevator, rudder, throttle, and ailerons. DO NOT OMIT AILERONS.
Dihedral angle: Build the "aerobatic" wing (the one with the least dihedral). This wing will fly more cleanly than the others, and because you'll have aileron control, you won't need a lot of dihedral to turn the airplane.
Balance point: Balance as shown on the plans.
On-board electronics and pushrod arrangements: See THE MANUAL and the plans.
Elevator and rudder pushrod type: Wood
Control throws: Set these up as recommended in THE MANUAL. The ailerons will probably be touchy at first. If so, reduce throw a little at a time with the advice and assistance of your instructor. If your Tx has rate switches and you fly on low rate, you can dial in throw changes as needed.

General Hardware and Materials Sizes

Fuel tank: 8 to 10 ounces
Wheel collars: 5/32"
Engine: .40 two-stroke
Propeller: 10/6
Spinner: 2¼"
Wheels:
- Main Wheels: 3¼"
- Nosewheel: 2¾"

Fire Wall Hardware

Quantity	Item
8	4-40 machine screws with washers
8	4-40 blind nuts
4	6-32 machine screws with washers
4	6-32 blind nuts

(Note: Many of these items are supplied in your kit. Count what you find and buy only what isn't provided.)

SPECIFICATIONS FOR THE GOLDBERG EAGLET 50

Test Plane Specifications

Wingspan: 50"
Wing area: 450 square inches
Weight: 60 ounces (3 pounds, 12 ounces)
Wing loading: 19.2 ounces per square foot
Radio: Futaba Conquest 4-channel
Engine: Fox .19 BBRC, 2-stroke
Propeller: 9/5 Top Flite

Setup Recommendations

Controls: 4 channels — elevator, rudder, throttle, and ailerons. DO NOT OMIT AILERONS.
Dihedral angle: Build the "aerobatic" wing (the one with the least dihedral). This wing will fly more cleanly than the others, and because you have aileron control, you won't need a lot of dihedral to turn the airplane.
Balance point: Balance as shown on the plans.
On-board electronics and pushrod arrangements: See THE MANUAL, and the plans.
Elevator and rudder pushrod type: Wood
Control throws: Set these up as recommended in THE MANUAL. Ailerons will probably be touchy at first. If so, reduce the throw a little at a time with the advice and help of your instructor. If your Tx has rate switches and you fly on low rate, you can dial in throw changes as needed.

General Hardware and Materials Sizes

Fuel tank: 4 ounces
Wheel collars: ⅛"
Engine: .19 to .25. Don't use an engine smaller than .19 cubic inch.
Propeller: 9.5 or 9.6
Spinner: 2"
Wheels:
- Main Wheels: 2¾"
- Nosewheel: 2¼"

Fire Wall Hardware

Quantity	Item
12	4-40 machine screws with washers
12	4-40 blind nuts

(Note: Many of these items are supplied in your kit. Count what you find there and purchase only what isn't provided.)

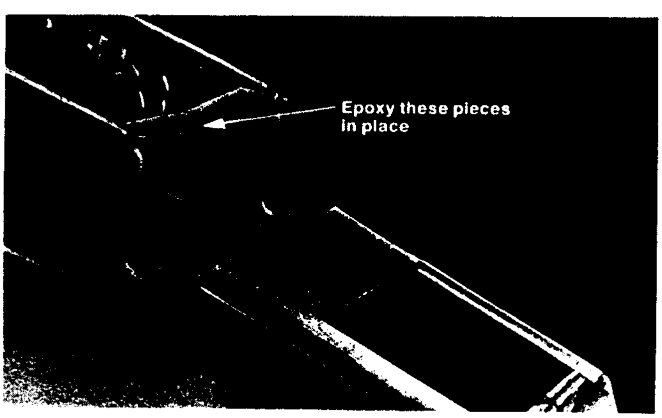
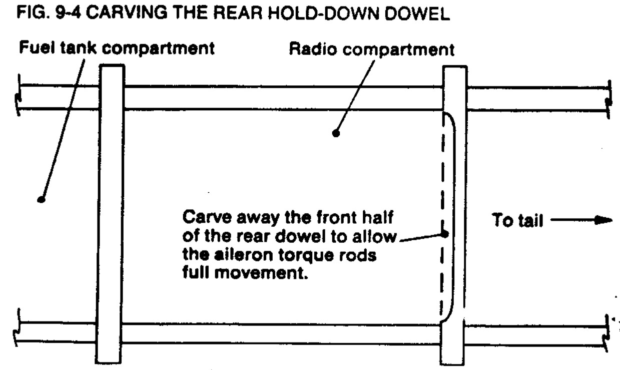


Fig. 9-3. Use epoxy to glue the windshield top former in place.

FIG. 9-4 CARVING THE REAR HOLD-DOWN DOWEL



warped. A slight warp is okay, but if you hold the tail on the workbench and the nose rises more than three inches, you'll need to flatten it out. To do this, throw the warped side into the bathtub and cover it with hot water. After it has soaked an hour or so, place it on your building surface and weight it down flat. I use bricks for this job, but anything that won't dent or color the wood is okay. Allow the side to dry at least overnight. When it's bone dry, check to see if it's still warped. If it is, you'll have to resoak it, prop it up in the center, and weight the two high ends. Keep at it until you've reduced the warp to an acceptable amount.

3) Fire wall preparation: Don't drill holes for the throttle and steering pushrods until you begin preliminary radio installation (Chapter Four in THE BOOK). The model will be completely framed by then.

4) Fire wall/fuselage gap: After you've glued the fuselage together, check to see if there is a gap between the fire wall and the bottom sheeting (see Fig. 9-2). If there is, fill it with epoxy to prevent oil from leaking in when you run the engine.

5) Dashboard (Eaglet only): Before installing the dashboard in the Eaglet 50, cut it along the curved mark. This will give you needed room for the fuel tank.

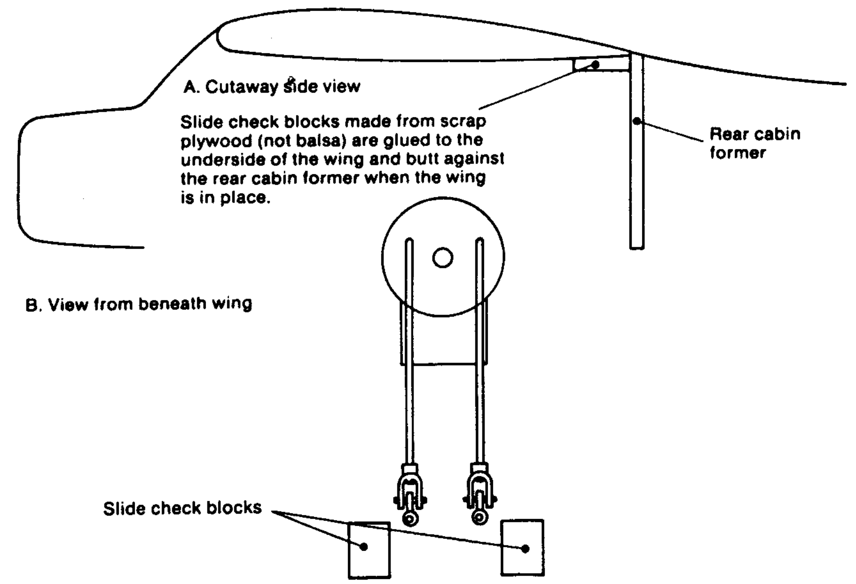
6) Trimming the forward cabin former: If you use even a moderately large tank, you'll have to trim this former so it not only clears the tank, but leaves room for the foam rubber padding that protects the tank.

7) Gluing the windshield top former: Glue this part in place with epoxy (see Fig. 9-3). It's hard to make a secure joint with CA.

8) Rear hold-down dowel: Cut away half the thickness of the rear hold-down dowel inside the fuselage as shown in Fig. 9-4. This will give the aileron torque rods room for complete movement.

9) Servo rail installation: Complete this operation according to THE MANUAL's instructions, but brace the rails as shown in Fig. 4-13 (page 17). Then turn to Chapter Four in THE BOOK and begin preliminary radio installation.

FIG. 9-5 SLIDE CHECK BLOCKS



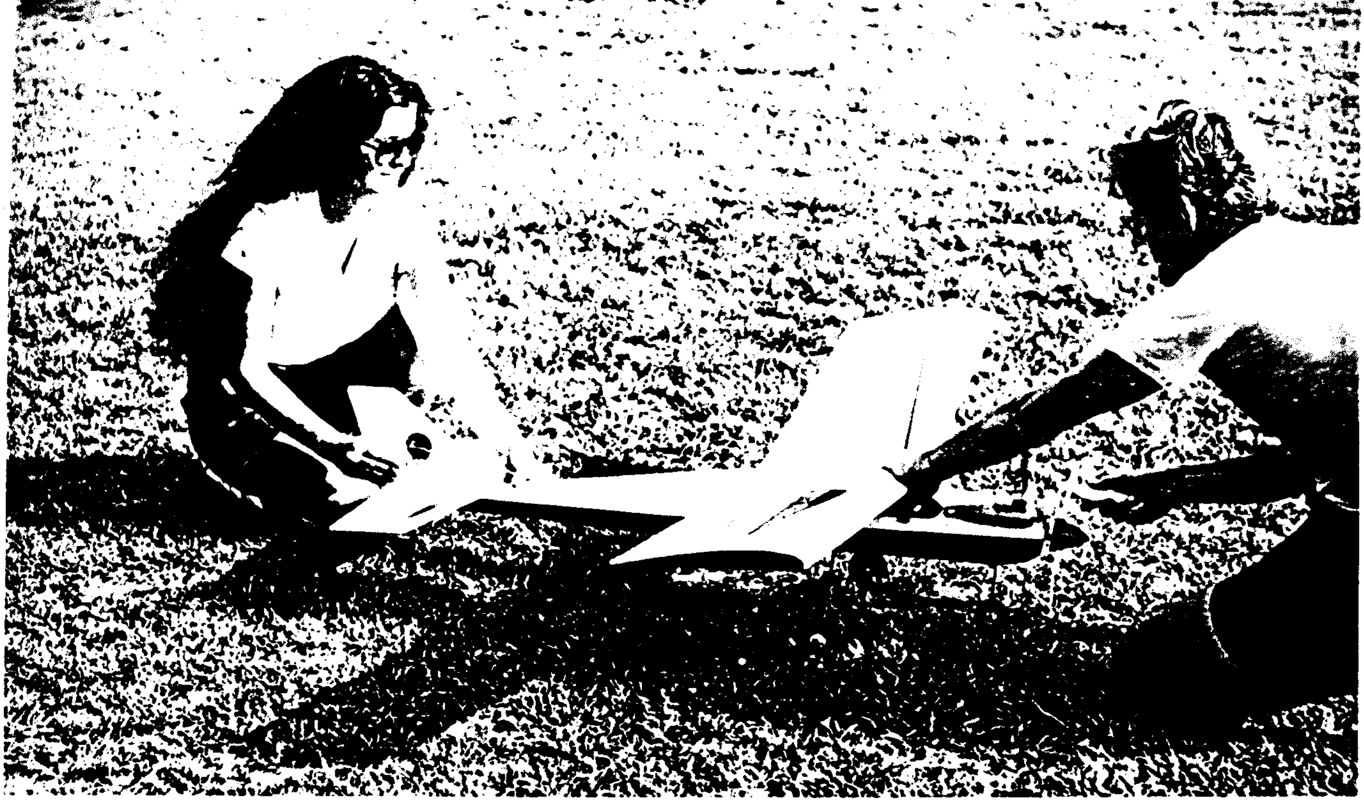
POST FRAMING ASSEMBLY

1) Slide check blocks: The wing on this airplane tends to slide to the rear, so the original design called for slide check blocks. If you're building an Eagle 63 or Eaglet 50, the plans should show you where to put them. I couldn't find them on the plans for my Eagle 2, but they should be installed anyway. Figure 9-5 shows how to make and install them. Don't do this until after covering the wing.

2) Post-covering assembly: Turn to Chapter Six for such operations as hinging control surfaces, installing the horizontal stabilizer, and so on.

3) Final radio installation: Ignore THE MANUAL on this subject except to get the proper size and shape for the pushrods and the positions of the servo rails and tray. Turn to Chapter Seven for all other final radio installation procedures.

4) Final touches: Once you've finished the radio installation, turn to Chapter Eight for final adjustments, balance, and assorted odds and ends.



10. Building the Great Planes PT-20 and PT-40

This plane requires Gold-N-Rods

With the following exceptions, frame the Great Planes PT-20 and 40 according to the instructions in THE MANUAL.

One caution: If you're installing a K & B engine with a radial mount, follow the installation instructions in THE MANUAL. However, install throttle and nose gear cables as instructed in Chapter Four of THE BOOK. Don't use the solid pushrod wires that come with the kit.

HINGE INSTALLATION

No matter what THE MANUAL says, don't cut hinge slots or install hinges until after the model has been covered. Then follow the instructions in Chapter Six of THE BOOK. Throw out the hinge material that comes with the kit and use CA hinges.

FUSELAGE CONSTRUCTION

1) Before gluing anything, use your razor saw to cut the ¼" lower triplers (called doublers in some MANUALS) down to ⅛"; this will give you needed room for engine and nose gear installation. Later, you'll add braces to more than compensate for any forfeiture of strength caused by thinning the triplers.

2) Because of the tail design in this airplane, it is difficult to install wooden pushrods so they can't hang up (see Fig. 10-1). Use Sullivan Gold-N-Rods instead of the wood pushrods shown in THE MANUAL. Because you'll use a different pushrod system, you'll need to cut the pushrod openings not as shown in THE MANUAL, but as shown in Fig. 10-2. Don't cut any openings until you get to Chapter Four (Preliminary Radio Installation).

3) Before you begin rubber banding the fuselage sides over formers, sand off any burrs on the wood that could interfere with a perfect fit.

4) Don't plank the top of the fuselage until after you've completed preliminary radio installation (Chapter Four).

5) Don't drill the holes for the throttle or steering "pushrods" until you commence preliminary radio installa-

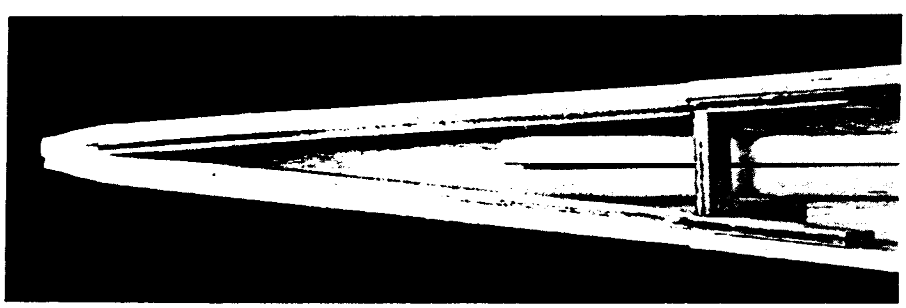
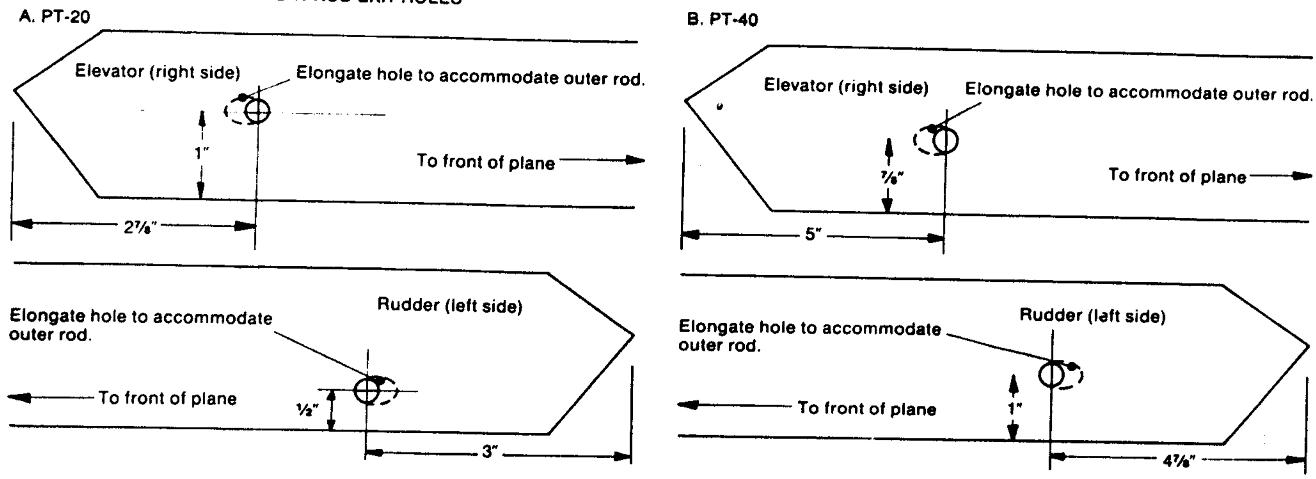


Fig. 10-1. This tight fit is why I recommend substituting Gold-N-Rods. Wood pushrods could easily hang up if you didn't install them perfectly.

FIG. 10-2 LOCATIONS OF GOLD-N-ROD EXIT HOLES



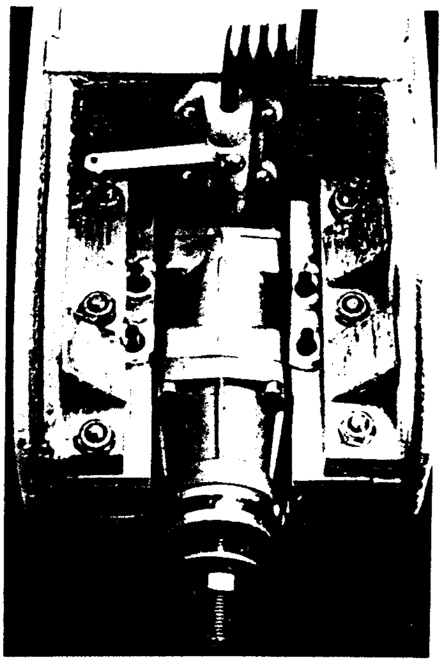


Fig. 10-3. Add braces under the engine bearers. Note that there are only three braces. The fourth, if installed, would interfere with the steering arm.

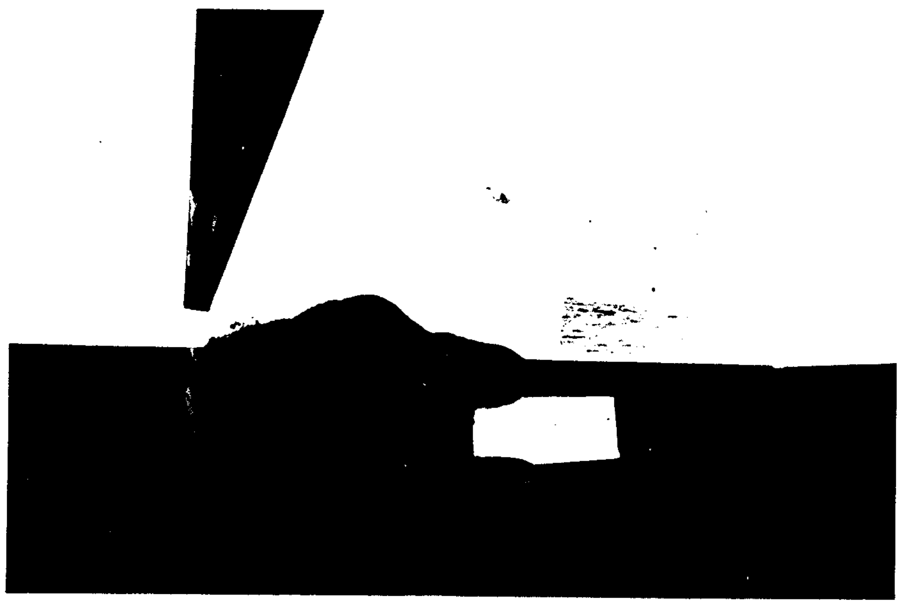


Fig. 10-4. After covering the wing, glue the wing plates in place. Strip away the wing covering to provide a solid wood-to-wood joint.

tion. Then follow the instructions in THE BOOK.

6) THE MANUAL says to screw the breakaway plates in place, but for security you should bolt them with 4-40 machine screws and blind nuts.

7) Because you cut the triplers down, it's a good idea to install braces under the engine bearers, as shown in Fig. 10-3.

8) Don't mount the stab and fin on the fuselage until after the plane has been covered. See Chapter Six (Post-Covering Assembly) for details.

FRAMING THE WING

1) Setting the dihedral: Build the aileron wing (the one with less dihedral). Take pains to fit the spars together perfectly. This is more important on PT models than on most planes because the PT planes have no balsa sheeting on top of the wing.

2) Joining the wing panels: Use thirty-minute epoxy for this job. Don't even consider using faster epoxy!

3) Aileron torque rods:

a. When you cut the groove for the torque rod bearing, be sure to make it deep enough to accept the whole bearing. Otherwise the trailing edge piece won't fit, which means the wing won't quite fit the saddle and the plane won't fly right.

b. Use epoxy glue, not CA, to install the torque rods. CA can easily get into the bearings and restrict movement. Epoxy is less of a problem, but to be sure, use petroleum jelly to keep glue out of the bearings (see Fig. 9-1, page 48).

c. Drill torque rod holes in the ailerons, then elongate them by rocking the drill. See Chapter Six for details.

d. Wing plates: Don't install these until after they and the wing have been covered (see Fig. 10-4).

e. Wing hold-down dowels: Replace the $\frac{5}{16}$" dowels in your kit with longer ones. Dowels should protrude ⅞" to 1" from each side of the fuselage.

f. Test fitting the wing: Make four sets of knotted rubber bands and use two on each side to test fit the wing (see Fig. 10-5). These will provide enough tension to hold the wing in place but not enough to damage the trailing edge. You'll strap the wing tighter when flying, but by then you'll have installed the wing plates.

NEEDLE VALVE CUTOUT IN FUSELAGE

Cut out enough of the fuselage front to allow easy access to the needle valve

SPECIFICATIONS FOR THE PT-20

Test Plane Specifications

Wingspan: 52¼"
Wing area: Approximately 525 square inches
Weight: 62 ounces (3 pounds, 14 ounces)
Wing loading: Approximately 17 ounces per square foot
Radio: Futaba Conquest 4-channel
Engine: Fox .15 BBRC two-stroke (Note: This is an excellent engine, but too small for this plane. Use a .19 to .25.)
Propeller: 8/4 Top Flite

Setup Recommendations

Controls: 4 channels — elevator, rudder, throttle, and ailerons. DO NOT OMIT AILERONS.
Dihedral angle: THE MANUAL gives you two dihedral options. Build the wing with the lesser dihedral.
Balance point: Balance as shown on the plans. Also see THE MANUAL for lateral balancing.
On-board electronics and pushrod arrangements: See the accompanying drawing.
Elevator and rudder pushrod type: Gold-N-Rods
Control throws: Set these up as recommended in THE MANUAL. Ailerons will probably be touchy at first. If so, decrease aileron throw a little at a time with the assistance of your instructor. If your Tx has rate switches, you can dial in these changes as needed.

General Hardware and Materials Sizes

Fuel tank: 4 ounces
Wheel collars: 5/32"
Engine: .19 to .25 two-stroke
Propeller: 9/5 to 9/6
Spinner: 2"
Wheels:
Main Wheels: 2¾"
Nosewheel: 2¼"

Fire Wall Hardware

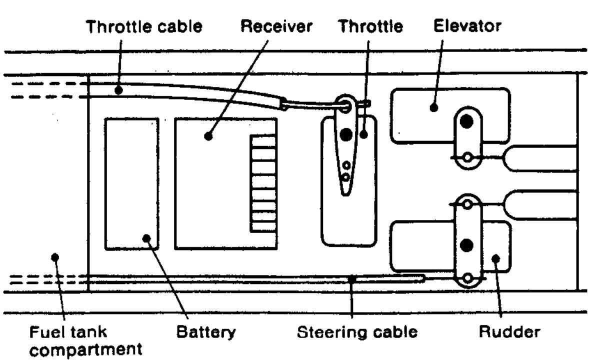
Quantity	Item
12	4-40 machine screws with washers
12	4-40 blind nuts

Pushrods

Quantity	Item
4	Metal with 2-56 thread at one end
1 set	Gold-N-Rods, semi-flexible

(Note: Many of these items come with your kit. Buy only what isn't provided.)

Radio component arrangement recommended for Royal 40T, Royal 20T, and Great Planes PT-40.



NOTE: While all four planes can use this arrangement, the Roya-Air 20T and 40T use wooden pushrods while the Great planes PT-20 and PT-40 should be built with Gold-N-Rods.

SPECIFICATIONS FOR THE PT-40

Test Plane Specifications

Wingspan: 60"
Wing area: 675 square inches
Weight: 87 ounces (5 pounds, 7 ounces)
Wing loading: 18.6 ounces per square foot
Radio: ACE Silver Seven
Engine: Royal .40 two-stroke
Propeller: 10/6 Top Flite

Setup Recommendations

Controls: 4 channels — elevator, rudder, throttle, and ailerons. DO NOT OMIT AILERONS.
Dihedral angle: THE MANUAL gives you two dihedral options. Build the wing with the least dihedral.
Balance point: Balance as shown on the plans. Also see THE MANUAL for lateral balancing.
On-board electronics and pushrod arrangements: See the accompanying drawing.
Elevator and rudder pushrod type: Gold-N-Rods
Control throws: Set these up as recommended in THE MANUAL. Ailerons will probably be touchy at first. If so, reduce throw a little at a time with the advice and assistance of your instructor. If your Tx has rate switches and you fly on low rate, you can dial in control throw changes as needed.

General Hardware and Materials Sizes

Fuel tank: 8 to 10 ounces
Wheel collars: 5/32"
Engine: .40 two-stroke
Propeller: 10/6
Spinner: 2¼"
Wheels:
Main Wheels: 3"
Nosewheel: 2½"

Fire Wall Hardware

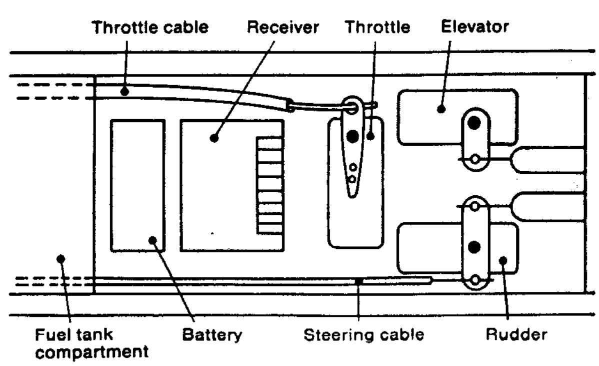
Quantity	Item
8	4-40 machine screws with washers
8	4-40 blind nuts
4	6-32 machine screws with washers
4	6-32 blind nuts

Pushrods

Quantity	Item
4	Metal with 2-56 thread at one end
1 set	Gold-N-Rods, semi-flexible

(Note: Many of these items come with your kit. Buy only what isn't provided).

Radio component arrangement recommended for Royal 40T, Royal 20T, and Great Planes PT-40.



NOTE: While all four planes can use this arrangement, the Roya-Air 20T and 40T use wooden pushrods while the Great planes PT-20 and PT-40 should be built with Gold-N-Rods.

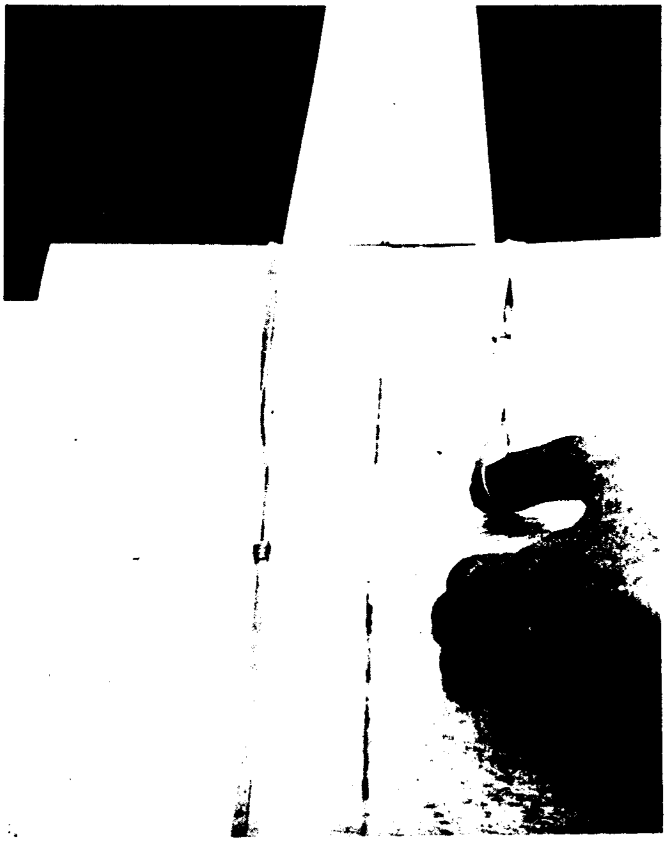
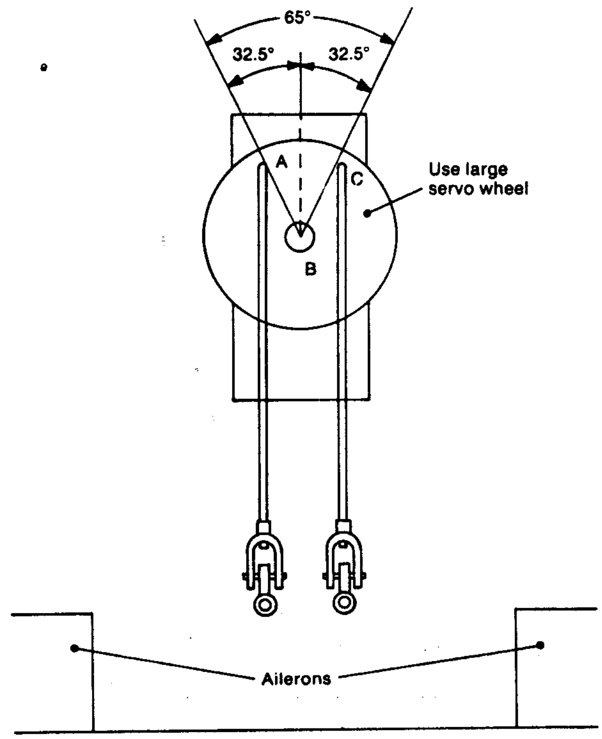


Fig. 10-5. Before the wing plates are in place you have to be gentle with the wing. To test fit the wing, tie rubber bands together as shown so that they're twice as long as normal. They'll hold the wing well enough for now and won't exert enough pressure to damage the trailing edge.

FIG. 10-7 DIFFERENTIAL AILERON THROW



On the PT-20 and PT-40 you must get much more up aileron movement than down aileron movement. To do this drill holes in a large servo wheel as shown. The angle A B C made by the pushrod holes A and C and the servo shaft B should be 65 degrees.

Fig. 10-6. Cut away enough of the cowl block to allow easy access to the needle valve with the engine running.

(see Fig. 10-6). If you try to turn the needle valve with the engine running and the cutout is too small, you could stick a finger into the prop (which I can tell you from experience is not what you want).

BALANCING THE PLANE LATERALLY

Be sure the muffler is in place when you do this.

SERVOS, PUSHRODS, AND OTHER RADIO-RELATED INSTALLATIONS

Ignore THE MANUAL and work from Chapter Four (Preliminary Radio Installation) and Chapter Seven (Final Radio Installation).

DIFFERENTIAL AILERON THROW

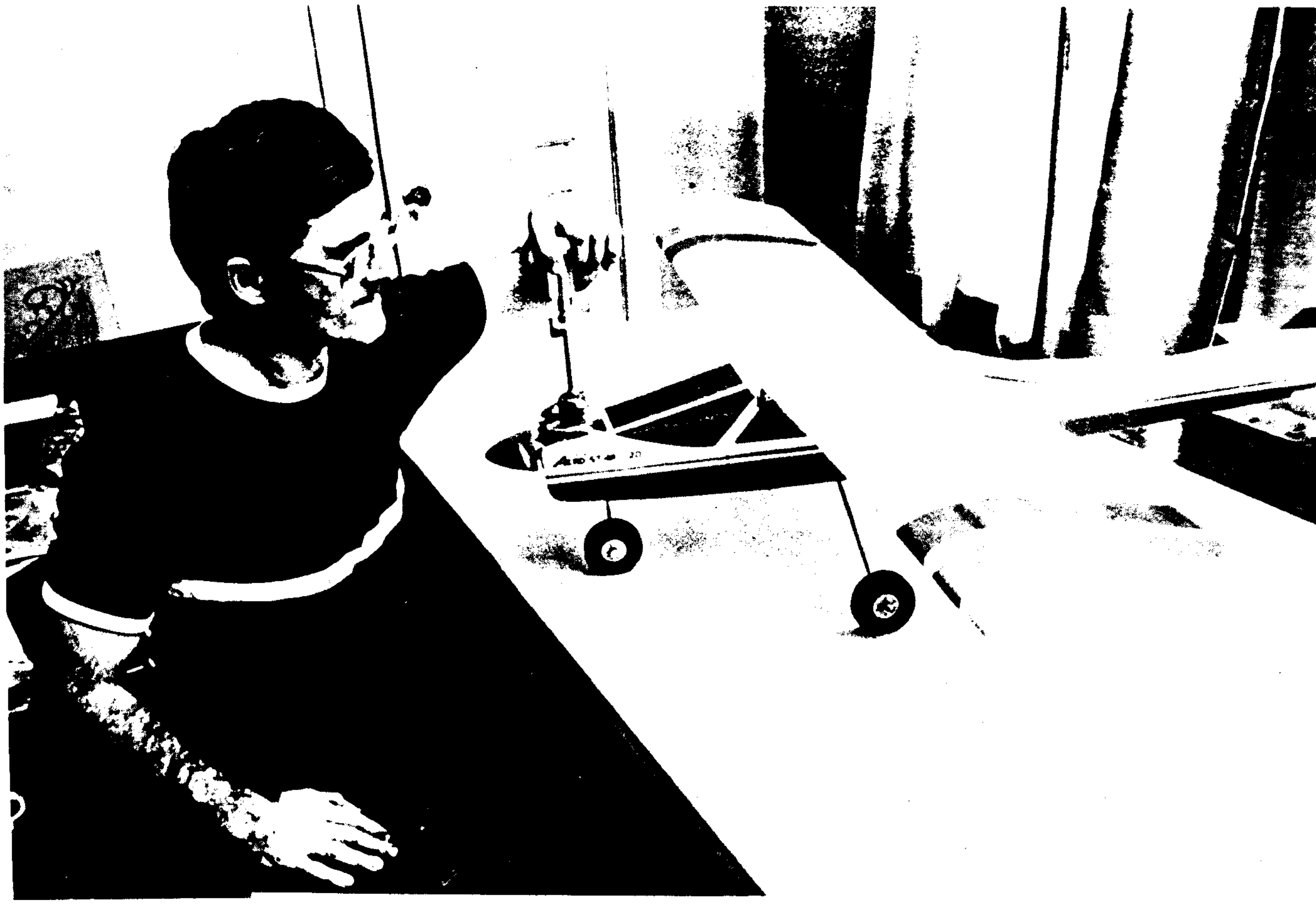
Because of the large dihedral angle, these planes won't respond well to aileron commands unless the aileron that moves up travels farther than the aileron that moves down. To achieve this differential throw you have to use a large servo wheel and connect the pushrods to it as shown in Fig. 10-7.

COMPLETING THE AIRPLANE

See Chapters Five, Six, Seven, and Eight of THE BOOK.

ADDING WASHOUT

This is a difficult job and the plane flies well without washout. You can skip it and still have a good, gentle trainer. If you decide to use washout, follow THE MANUAL's instructions.



11. Building the Midwest Aero-Star 20 and Aero-Star 40

With the fc wing exceptions, frame the Aero-St models according to the instruction THE MANUAL.

THE TAIL

Follow MANUAL's directions with one chan You'll be using CA hinges, which a nstalled after the plane is covered o not mark hinge positions or cut ge slots until after covering the pl See Chapter Six for hinging detail

THE FUSELAGE

1) fore gluing any parts together, ren all burrs with your modeling kn and sanding block. If you don't, yc get weak joints and a crooked f age.

When gluing the balsa triangle es that will later support the fire l to the fuselage sides, position the t brace so that it covers the line you ew for it. Position the right brace ver the rear edge of the line that you drew for it. This will build in a little right engine thrust, which is preferable to left thrust.

3) Don't get too attached to the pre-drilled throttle and steering pushrod holes. Fill them in with five-minute epoxy as Fig. 4-15, page 18, shows. Later you'll redrill them in slightly different positions to take the cable pushrods that replace the solid rods supplied with the kit.

4) Nose gear bracket: You may have to sand a bit off the top of the bracket so it will line up with the pre-drilled mounting holes. I had to do this on the Aero-Star 20, but not on the Aero-Star 40.

5) Gluing the fire wall in place:

a. Before you start gluing, check to be sure that the engine will not have left thrust when installed. If necessary add a thin shim to the left side of the fire wall brace to overcome any left thrust. If anything, the fire wall should be canted a degree or less to the right.

b. Use 30-minute epoxy for this job so you don't have to rush it.

c. Once the fire wall's secured in place with two pieces of tape, wipe off excess epoxy with a tissue soaked in rubbing alcohol. The idea is to keep the fire wall smooth so that later you can glue the cowl blocks squarely to it.

6) Anti-slide block: Nowhere in THE MANUAL does it tell you to install this item, but you should. Make the block of 1/8" plywood scrap and glue it just behind the wing saddle as shown in Fig. 11-1.

WING CONSTRUCTION

Caution: THE MANUAL suggests that you may want to fly with the ailerons disconnected. You just might get away with it, but it's not a good idea. Don't do it.

FRAMING THE WING

1) Applying the top leading edge sheeting: Use slow CA for this job, as

SPECIFICATIONS FOR THE AERO-STAR 20

Test Plane Specifications

Wingspan: 52½"
Wing area: approximately 472 square inches
Weight: 65 ounces (4 pounds, 1 ounce)
Wing loading: approximately 19.8 ounces per square foot
Radio: Futaba Conquest 4 channels
Engine: Fox .19 BBRC
Propeller: 9/6 Top Flite

Setup Recommendations

Controls: 4 channels — elevator, rudder, throttle, and ailerons. DO NOT OMIT AILERONS.
Dihedral angle: Set up as directed in THE MANUAL.
On-board electronics and pushrod arrangements: Put the components in the order THE MANUAL shows but employ hardware specified in THE BOOK.
Elevator and rudder pushrod type: Wood
Control throws: Set these up as suggested in THE MANUAL. The ailerons will probably be touchy at first. If so, decrease the throw a little at a time with the help of your instructor. If your Tx has rate switches and you fly on low rate, you can dial in control throw changes as needed.

General Hardware and Materials Sizes

Fuel tank: 4 ounces
Wheel collars: 5/32"
Engine: .19 to .25 two-stroke. Don't use any engine smaller than .19 cubic inch.
Propeller: 9/5 to 9/6
Spinner: 2"
Wheels:
Main Wheels, 2¾"
Nosewheel, 2½"

Fire Wall Hardware

Quantity	Item
12	4-40 machine screws with washers
8	4-40 blind nuts
4	4-40 lock nuts with nylon inserts

(Needed only if you don't tap the engine mount.)

Pushrods

Quantity	Item
6	metal pushrod with 2-56 thread at one end

(Note: Many of these items are supplied in your kit. Buy only what isn't provided.)

Special Tools

4-40 tap and handle (needed only if you tap the engine mount)

SPECIFICATIONS FOR THE AERO-STAR 40

Test Plane Specifications

Wingspan: 62"
Wing area: 675 square inches
Weight: 84 ounces (5 pounds, 4 ounces)
Wing loading: 17.9 ounces per square foot
Radio: ACE Silver Seven, 5-channel (4 used)
Engine: O. S. .40
Propeller: 10/6 Master Airscrew

Setup Recommendations

Controls: 4 channels — elevator, rudder, throttle, and ailerons. DO NOT OMIT AILERONS.
Dihedral angle: Set up as directed in THE MANUAL.
On-board electronics and pushrod arrangements: Arrange components as shown in THE MANUAL, but use hardware specified in THE BOOK.
Elevator and rudder pushrod type: Wood
Control throws: Set these up as recommended in THE MANUAL. The ailerons will probably be touchy at first. If so, reduce the throw a little at a time with the assistance of your instructor. If your Tx has rate switches and you fly on low rate you can dial in control throw changes as needed.

General Hardware and Materials Sizes

Fuel tank: 8 to 10 ounces
Wheel collars: 5/32"
Engine: .40 two-stroke
Propeller: 10/6
Spinner: 2¼"
Wheels:
Main Wheels, 3"
Nosewheel, 2¾"

Fire Wall Hardware

Quantity	Item
8	4-40 machine screws with washers
8	4-40 blind nuts
4	6-32 machine screws with washers
4	6-32 lock nuts with nylon inserts (needed only if you don't tap the engine mount)

Pushrods

Quantity	Item
6	metal pushrod with 2-56 thread at one end

(Note: Many of these items are supplied in your kit. Buy only what isn't provided.)

Special Tools

6-32 tap and handle (needed only if you tap the engine mount)

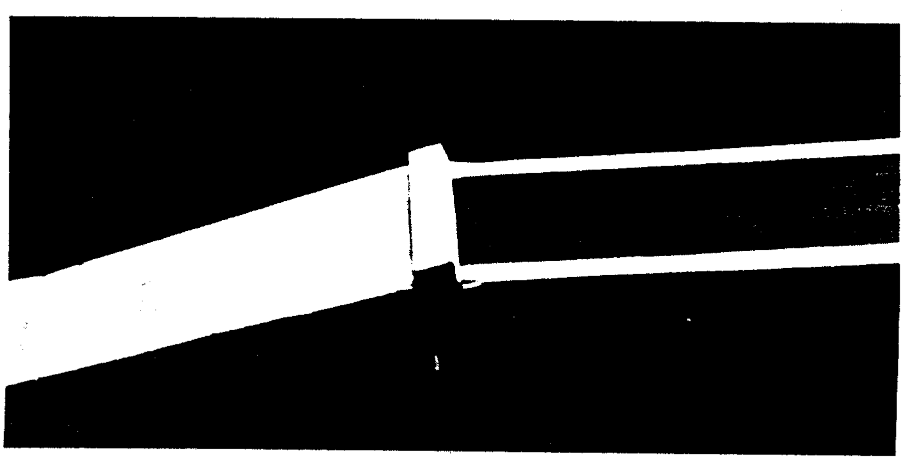


Fig. 11-1. Install the anti-slide block just behind the wing saddle.

THE MANUAL says, but use accelerator to be sure the glue grabs." Otherwise you may stand there all night waiting.

2) Torque rod installation. Installing torque rods is a critical step, and the trick is to glue the torque rod box in place without getting glue on the rods themselves. THE MANUAL suggests you apply light oil to the rods before gluing with CA. I suggest you use petroleum jelly and do the gluing with epoxy, which is less adept at gluing oily surfaces than CA is.

Before either gluing anything or applying petroleum jelly on the rods, trial fit each assembly. On my Aero-Stars the torque rod box was thinner than the trailing edge of the wing. To m

the planes look better, I aligned the top of the wing with the top of the box and glued the assembly in that position (see Fig. 11-2). That left a bit of an undercut on the underside of the wing, but at least it was out of sight.

Once the torque rods have been installed, check the degree of movement. The rods should be able to move 45° in either direction. If the range is less than this, lengthen the notches in the torque rod box or wing trailing edge, or both, as needed.

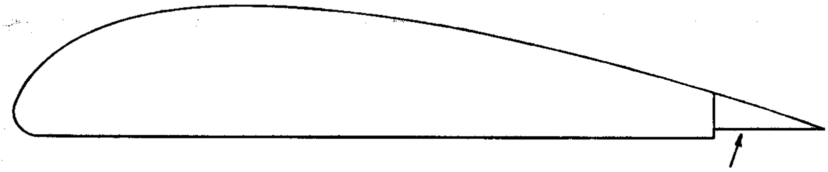
3) Aileron preparation: You'll have to drill a hole in each aileron to accept the torque rod. THE MANUAL tells you to use a 5/32" drill. That's fine, but once you've drilled the hole, rock the drill back and forth to elongate the hole as shown in the drawing in Chapter Six (Fig. 6-23, page 39). When you install the aileron, you'll fill this hole with epoxy, creating a large bearing surface and decreasing the likelihood that vibration will work the rod loose.

4) Aileron hinges: Don't mark or cut any hinge slots until after the plane is covered. Then use CA hinges and follow the procedure in Chapter Six (Post-Covering Assembly).

5) Wing hold-down dowels: Replace the 5/16" kit dowels with longer ones of the same diameter. These must project 7/8" to 1" from each fuselage side.

6) Shaping the wing fairing: Because you'll be using a wing seating tape which wasn't contemplated by THE MANUAL's authors, you'll need to raise the wing slightly while shaping the fairing. To do this, place a couple of strips of 3/32" balsa across the wing saddle and tack them in place with a few drops of thin CA glue before placing the wing on the saddle. After you've shaped the fairing, remove the wing and cut the balsa shims from the saddle.

FIG. 11-2 ALIGNING TORQUE ROD BOX WITH WING TRAILING EDGE



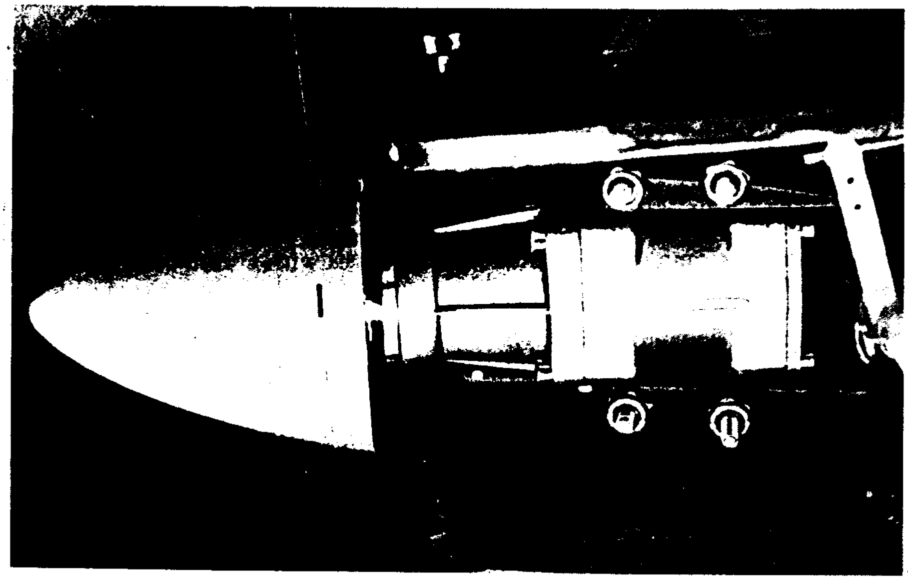


Fig. 11-3. If you do not tap the engine mount, you will need to retain the mounting bolts with nylon-insert lock nuts.

ENGINE INSTALLATION

1) Install the engine mount as shown in THE MANUAL but don't install the nylon tubes for the throttle and steering pushrods yet.

2) If you intend to tap the engine mount to take the mounting bolts, heed THE MANUAL's instructions on mounting the engine with the following exception: If you're using an engine larger than .25 cubic inch, use 6-32 mounting bolts, not 4-40 bolts. If you plan to secure the engine without tapping the mount (see Fig. 11-3), follow the instructions in Chapter Four (Preliminary Radio Installation).

COWL INSTALLATION

1) Replace the thick cowl blocks supplied in the kit. Cut your own to the same shape from 1/4"-thick balsa. This will allow you to use a longer steering arm, which will make for smoother ground handling and safer takeoffs.

2) After gluing the cowl blocks in place, temporarily install the engine and muffler. If necessary, trim the cowl to clear the muffler to allow easy access to the needle valve when the engine is running.

NOSE GEAR

One of the few problems with this design is the short steering arm, which makes for overly sensitive steering. It was to make room for a longer steering arm that I had you install thinner cowl blocks. Make the arm as long as you can, and use the outermost available hole for your steering cable connector. You'll have to relocate the steering arm hole in the fire wall to do this, which is why you filled in the predrilled steering cable hole with epoxy. See Chapter Four (Preliminary Radio Installation) for instructions on how to install the nose gear strut and drill the cable holes.

BRACING THE STAB PLATFORM

THE MANUAL provides you two options for gluing the stab to the fuselage. Choose the stronger option and glue 1/4" balsa fillet pieces inside the saddle as shown in THE MANUAL.

INSTALLING THE STAB

Don't do this yet. The model is now framed, so turn to Chapter Four (Preliminary Radio Installation). From this point on, you'll work almost exclusively from THE BOOK, which explains stab installation in Chapter Six (Post-Covering Assembly).

FUEL TANK INSTALLATION

Follow the instructions in THE MANUAL for this procedure.

LANDING GEAR INSTALLATION

See Chapter Six (Post-Covering Assembly) for most details on landing gear installation. However, the Aero-Star landing gear installation is unusual and is potentially susceptible to problem vibration, so I recommend you pack the gear struts in silicone glue. When you're ready to install the gear for the last time, here's what to do. First, smear glue over the exposed part of the landing gear block, then insert the landing gear legs and coat them with silicone glue. Finally, with the glue still wet, screw the cover plate in place.

DECALS

The Aero-Stars come with nice decals, but they won't last unless you fuelproof them. After applying them, seal the edges with clear polyurethane paint. Allow at least 24 hours' drying time before operating the engine.

12. Building the Royal-Air 20T and 40T

Build the Royal-Air models according to the instructions in THE MANUAL with the following clarifications, additions, and exceptions.

(No matter what you read in THE MANUAL, don't hinge any control surfaces until you get to Chapter Six [Post-Covering Assembly] in THE BOOK.)

JOINING THE WING PANELS

1) Before beginning work on the wing panels, check them for warps by laying them out on your flat working surface. If they hug the bench, all is well. If one part of a panel is raised by more than ⅛", you'll need to correct it as described in Chapter Eight (Final Touches). Caution: The covering material on these models is extremely heat-sensitive. Keep the trim iron temperature as low as possible and try to avoid heating the covering where it touches wood.

2) Preparing the spar joiners: When gluing the spar joiners together, use epoxy rather than CA glue, and clamp the pieces with C-clamps or a vise as shown in Fig. 12-1. Use waxed paper to separate the parts being glued from the clamps. Make sure the parts are perfectly aligned. If they aren't, you may not be able to insert the joiner into the wing panels. Before the glue sets, wipe off any excess with an alcohol-soaked tissue. A glob of cured epoxy can also keep the joiner from fitting.

3) Dry-fitting the spar joiner: Once the joiner is glued together, mark one side "front" and draw a vertical center line on it. Mark one half left and the other half right, as in Fig. 12-2. Test fit the joiner. It should go in all the way to the center line. If it doesn't, trim the end until it does. Repeat the procedure for the other wing panel. Now dry-fit the two wing panels together over the joiner. The center ribs should fit flat together and the leading and trailing edges of one wing should line up perfectly with the leading and trailing edges of the other wing. If necessary, trim the joiner to obtain this fit.

4) Gluing the wing panels together: This is a two-step operation. First you glue the joiner into one wing panel and allow the epoxy to cure. Then you mix more epoxy and glue the two panels together over the joiner. Read this section from start to finish before starting. Few feelings are as hopeless as being slower than your epoxy and ruining your airplane.

When you've got the procedure down perfectly and know that everything you need is within easy reach, mix the first batch of 30-minute epoxy (don't use a faster epoxy!). Smear it all over one half of the joiner and inside the slot that will accept the joiner. Insert the joiner into the slot at least to the center line and jiggle it around a few times to spread the epoxy inside the slot. This is the most important glue joint in the aircraft, so make sure the epoxy wets the wood completely, both on the joiner and in the slot. Remove the joiner, slobber more epoxy into the slot, and smear more onto the joiner. Now insert the joiner into the slot, lining up the center line with the center rib. Finally, clean excess epoxy from rib, joiner, wing surface, etc., with alcohol-soaked tissues and set the assembly aside to cure.

When the glue has completely cured, mix a second batch of epoxy and glue the second wing panel over the joiner protruding from the first panel, using the same techniques you used for the first, except that this time you'll smear epoxy over both center ribs before sliding the free panel over the joiner. When you're done, clean off all excess

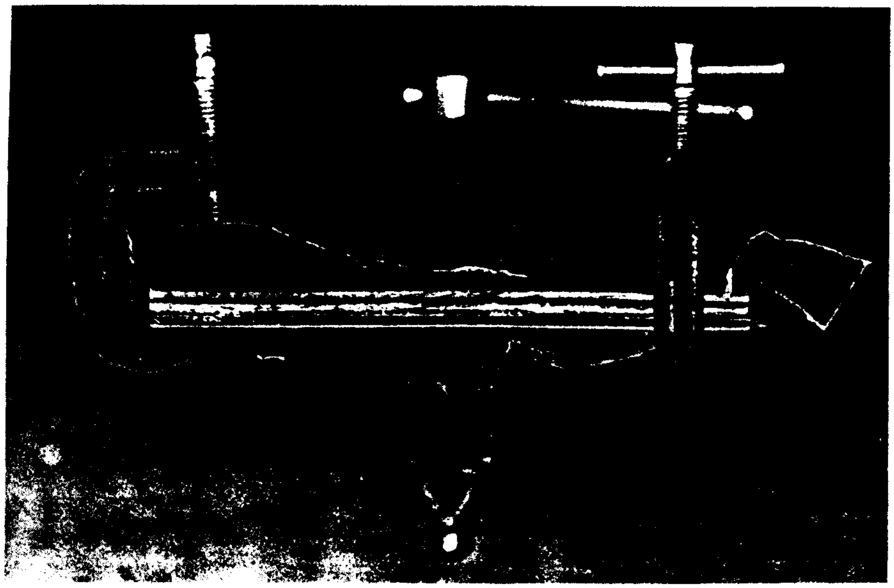
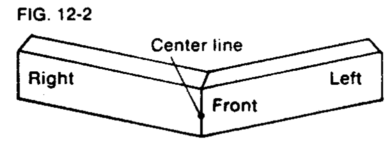


Fig. 12-1. Make sure that the parts are lined up, then clamp the spar joiner tightly while the epoxy cures.



If the brace doesn't go in all the way to the center line in both wing panels, trim the ends till it does.

epoxy with alcohol-soaked tissues, then apply the tape supplied in the kit to the center joint. Check to be sure the leading and trailing edges of the two wing panels are aligned with one another. If they're not, fix them now. Once the alignment is right, set the wing aside and let the glue cure undisturbed.

5) Reinforcing the wing center section: Now and then at any flying field you'll see a plane start to pull out of a steep dive only to have the wings fold from too much g force. The fuselage, unencumbered by wings, makes like a powered arrow and buries itself in the ground as the helpless pilot watches. To guard against this depressing event, reinforce the wing center section with fiberglass cloth. Figures 12-3–12-6 show you how to do this.

6) Fitting the wing to its saddle: Test fit the wing on its saddle. It should sit level with the center trailing edge butted against the rear of the saddle and the leading edge against the front of the saddle. On my 40T the wing didn't quite fit. If you have that problem, trim the rear of the trailing edge center section. This leaves exposed wood, which you will later need to fuelproof, along with the dowels and engine compartment.

7) Shortening the ailerons: The wings are held in place with rubber bands attached to dowels. As designed, the ailerons come perilously close to the dowels and just might lead to control hangup if your wing isn't centered. To be on the

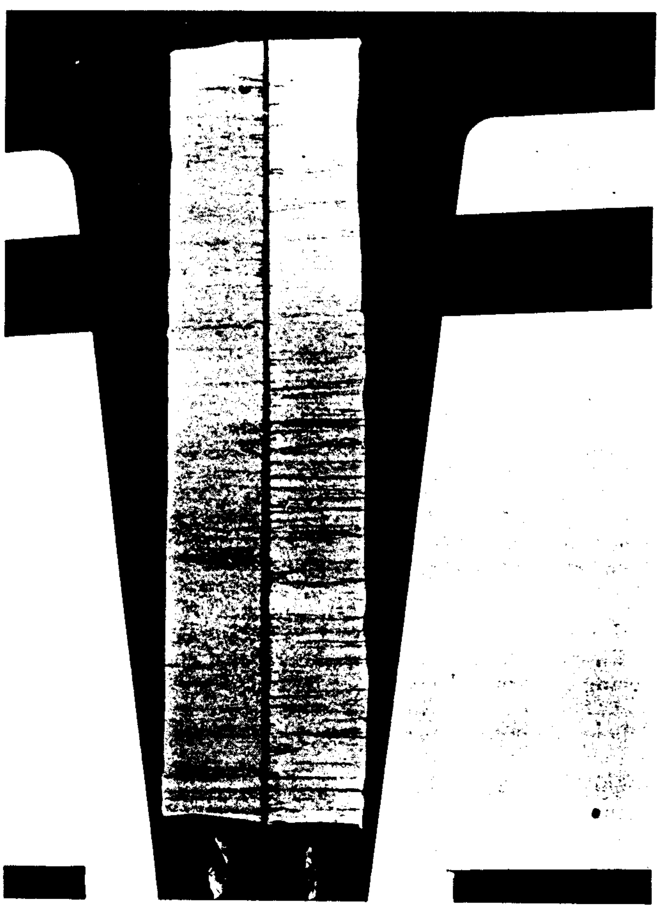


Fig. 12-3. Strip the center covering from the wing's underside.

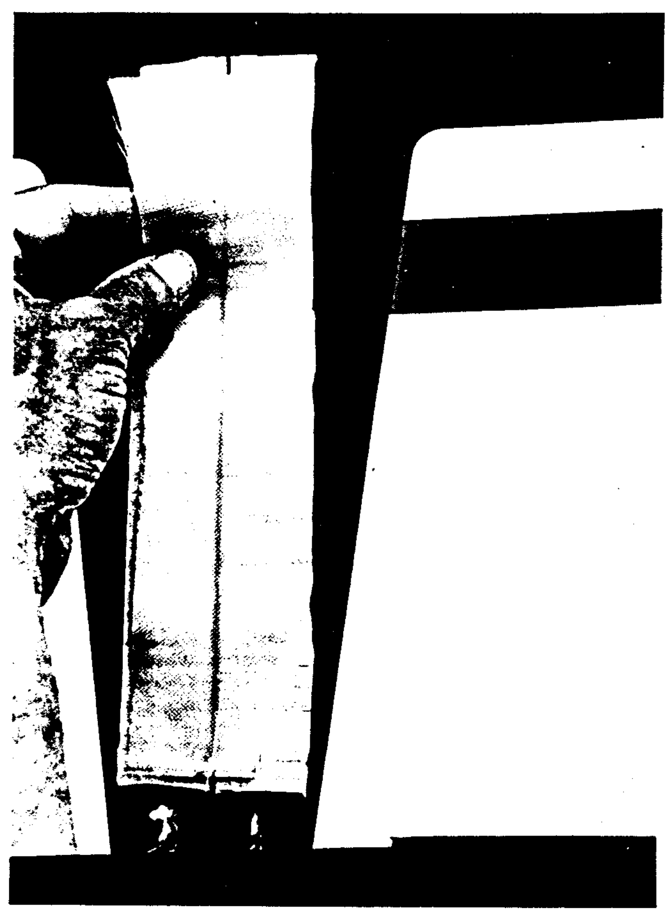


Fig. 12-4. Then cut a strip of lightweight fiberglass to size,

Fig. 12-5. . . . and glue it in place with thin CA.

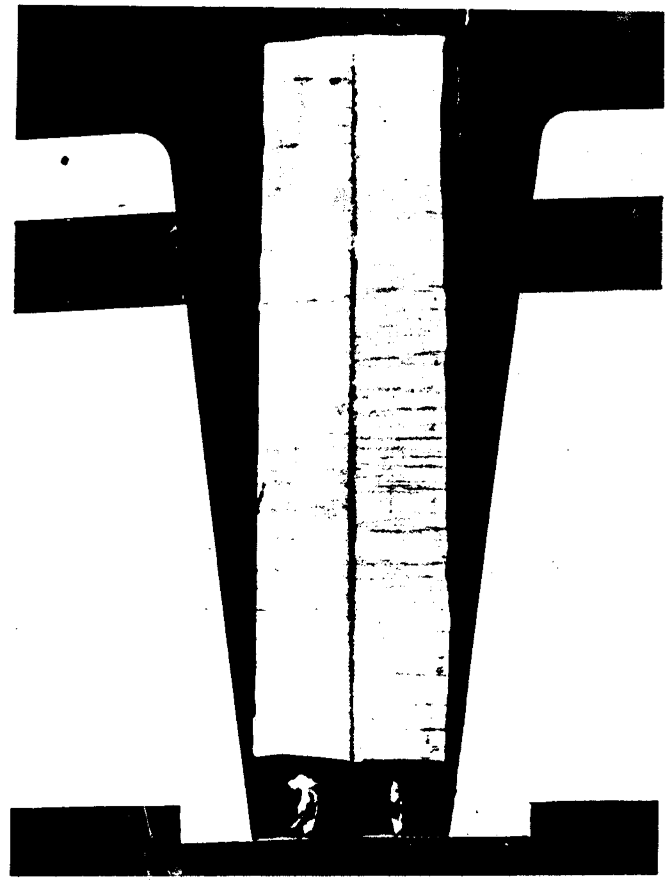
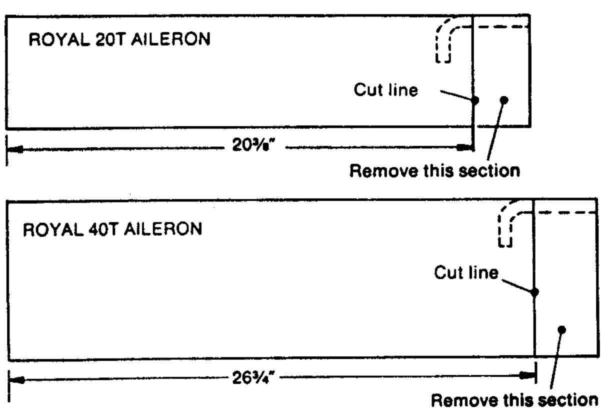


Fig. 12-6. The reinforced section should look like this and will be stronger than before you fiberglassed it.

FIG. 12-7 SHORTENING AILERONS



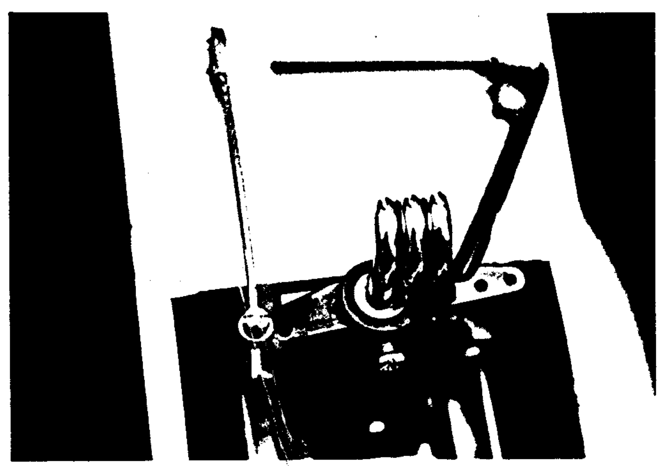


Fig. 12-8. On the 20T the steering cable goes through the fuselage bottom.

safe side, shorten each aileron before installing it. Be sure to cut the end that will be closest to the fuselage, not the tip end! On my 20T I cut the ailerons down to 20⅜", and on the 40T to 26¾". Don't cut too much off or the torque rods won't reach the ailerons (see Fig. 12-7).

8) Hinging the ailerons: The leaf hinges that come with the kit work fine, but since it takes skill and time to install them properly (it takes me about six hours) replace them with CA hinges, which are hard to ruin and which can be installed quickly. See Chapter Six (Post-Covering Assembly) for hinging procedures, but before you do, here's one caution about the precut hinge slots on the wing and tail parts of your plane. Don't use them! They're too big for CA hinges. Cut your own slots to one side of each precut one. Place one hinge as near as possible to each end of the control surface and space the others as evenly as you can between them.

9) Installing the aileron servo: The procedure in THE MANUAL will work, but use the method shown in Chapter Seven (Final Radio Installation). It's quicker and provides better security and vibration protection.

THE FUSELAGE (PROBLEM AREAS UP FRONT)

Fuelproof the fuel tank compartment and hatch cover with epoxy as shown in THE MANUAL. Or, if you prefer, you can use CA glue. While you're at it, check the fire wall. On both the 20T and 40T

SPECIFICATIONS FOR THE ROYAL-AIR 20T

Test Plane Specifications

Wingspan: 50½"
Wing area: 437 square inches
Weight: 64 ounces (4 pounds)
Wing loading: 21.1 ounces per square foot
Radio: Futaba Conquest 6-channels (only 4 channels used)
Engine: Royal .25
Propeller: 9/6 Top Flite

Setup Recommendations

Controls: 4 channels — elevator, rudder, throttle, and ailerons. DO NOT OMIT AILERONS.
Dihedral angle: Set up as directed in THE MANUAL.
Balance point: 3¾" aft of leading edge of the wing. Do not balance forward or aft of this point.
On-board electronics and pushrod arrangements: See the accompanying illustration.
Elevator and rudder pushrod type: Wood. Make your own. Don't use the pushrods supplied with the kit.
Control throws: Elevator should be 7/16" to ½" in either direction. This is more than THE MANUAL recommends, but you may need it to hold the nose up on landings. Set up the aileron and rudder throws as directed in THE MANUAL. If you find any control overly sensitive, reduce the throw a little at a time with your instructor's help. If your Tx has rate switches, you can just dial in any changes as needed.

General Hardware and Materials Sizes

Fuel tank: Use the tank supplied with the kit.
Wheel collars: 5/32"
Engine: .25 two-stroke
Propeller: 9/6
Spinner: Use the spinner supplied with the kit.
Wheels: You can get by with the wheels supplied in the kit, but I recommend larger ones for the mains.
Main Wheels: 2¾".
Nosewheel: 2¼"

Fire Wall Hardware

Use the fire wall hardware supplied in the kit.

Pushrods

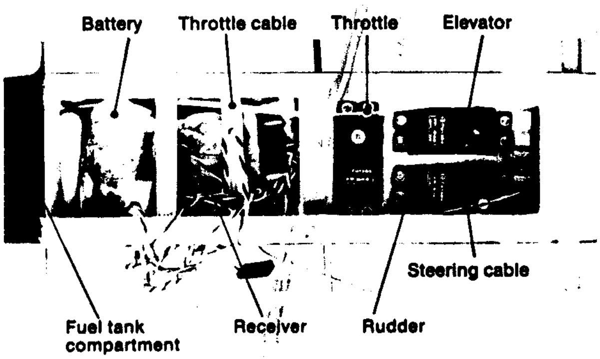
Metal with 2-56 thread at one end. Six required.

Note: Many of these items are supplied in the kit. Buy only what isn't provided.

Additional Materials

Fiberglass cloth strip for reinforcing wing center section

Radio component arrangement recommended for Royal 40T, Royal 20T, and Great Planes PT-40.



This is how to arrange the radio gear in the 20T fuselage. It is a tight fit.

SPECIFICATIONS FOR THE ROYAL-AIR 40T

Test Plane Specifications

Wingspan: 64"
Wing area: 736 square inches
Weight: 87.5 ounces (5 pounds, 7.5 ounces)
Wing loading: 17.1 ounces per square foot
Radio: Futaba Conquest 6-channel (use only 4 channels)
Engine: Royal .40
Propeller: 10/6 Top Flite

Setup Recommendations

Controls: 4 channels — elevator, rudder, throttle, and ailerons. DO NOT OMIT AILERONS.
Dihedral angle: Set up as directed in THE MANUAL.
Balance point: 4½" aft of the wing leading edge. Balance exactly at this point.
On-board electronics and pushrod arrangements: See the drawing for the 20T.
Elevator and rudder pushrod type: Wood. Make your own. Don't use the pushrods supplied with the kit.
Control throws: Use the throws recommended in THE MANUAL. If you find yourself overcontrolling with these throws, reduce them a little at a time with your instructor's help. If your Tx has rate switches and you fly on low rate, you can just dial in changes in throw as you need them.

General Hardware and Materials Sizes

Fuel tank: Use the tank supplied with the kit.
Wheel collars: 5/32"
Engine: .40 two-stroke
Propeller: 10/6
Spinner: Use the spinner supplied with the kit.
Wheels:
Main Wheels: 3" diameter — not the wheels supplied with the kit.
Nosewheel: Use one of the wheels supplied in the kit.

Fire Wall Hardware

Use the hardware supplied in the kit.

Pushrods

Metal rods with 2-56 thread at one end (6 required).

Note: Many of these items are supplied in the kit. Buy only what isn't provided.

Additional Materials

Fiberglass cloth strip for reinforcing center section. Standard steering arm to replace bell crank supplied in kit.

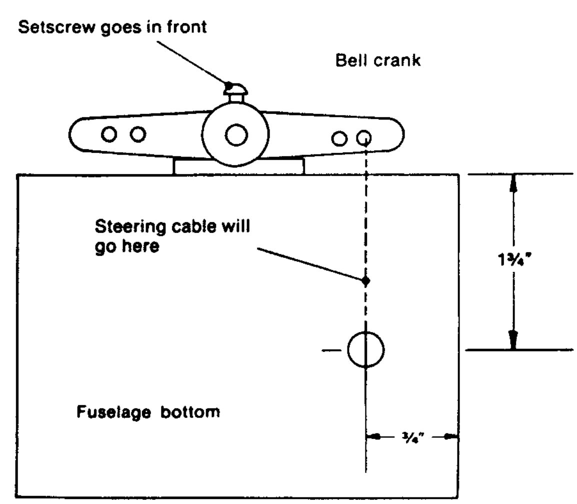
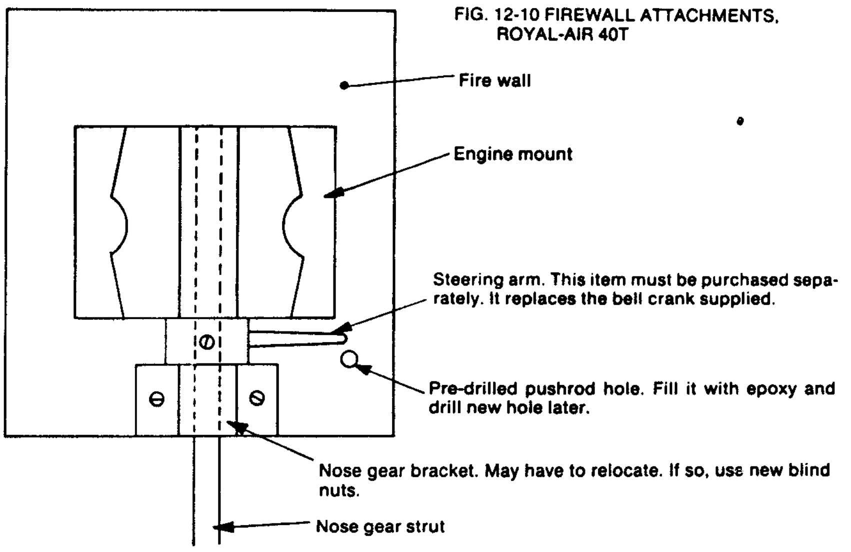


FIG. 12-9
LOCATION OF STEERING CABLE HOLE ON ROYAL-AIR 20T

FIG. 12-10 FIREWALL ATTACHMENTS, ROYAL-AIR 40T



you'll find a pre-drilled hole for the throttle pushrod. Plug it with five-minute epoxy. You'll drill a new hole later in a slightly different position. The 40T also has a hole for the steering pushrod. Plug that, too.

At this point THE MANUAL covers fuel tank installation, but before you worry about that, install the main landing gear, which is easy, and the nose gear, which is more complicated. Install the main gear first, following the sketches in THE MANUAL. You might have to radius the holes in the landing gear block to get the gear legs to fit properly, but you shouldn't have a problem beyond that. The nose gear and steering arm assemblies are done differently on the 20T and 40T.

Steering setup on the 20T: On the 20T the steering arm is a bell crank which fits below the nose gear bracket and poses no special problems. However, this plane is unusual in that the steering cable doesn't go through the fire wall, but enters the fuel tank compartment through the bottom of the fuselage (see Fig. 12-8). Figure 12-9 shows where to drill the cable hole in the fuselage. Note in Fig. 12-8 that the cable connector on the bell crank is installed upside down so it can't hang up on the fuselage. Install the nose gear and bell crank now. You'll connect the steering cable when you get to Chapter Four (Preliminary Radio Installation).

Steering setup on the 40T: On my 40T there were a couple of problems. First, the engine mount and nose gear mounting bracket were too close to allow installation of the steering arm, so I had to remove the bracket and the blind nuts behind it, plug the mounting holes with epoxy, drill new holes just below the first set, then reinstall the mounting bracket using new blind nuts. Now there was room to get the steering arm in place, but the arm provided with the kit was a bell crank which wouldn't line up with the steering cable I had to install later. I replaced the bell crank with a standard steering arm, after which all went smoothly (see Fig. 12-10).

Don't move the nose gear mounting bracket on your 40T unless you have to. However, you will have to replace the bell crank with a standard steering arm if you plan to use the cable steering pushrod I recommend, rather than the solid rod provided in the kit.

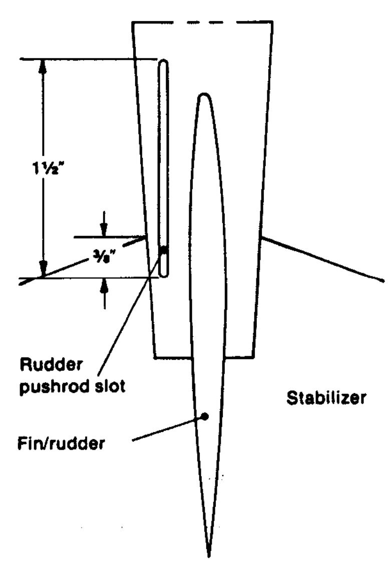
FUEL TANK ASSEMBLY

Reaming the opening: Slip a piece of fuel line over the end of the tank's clunk and see if the clunk will fit easily into the tank. Don't force it. You could get it in and not be able to retrieve it. If the fit is tight, ream the opening a bit with one blade of your needlenose pliers, then try again (see Fig. 12-11). Keep reaming until the clunk will just slip in without resistance.

Adjusting fuel line length: The silicone fuel line should be long enough that when you hold the tank with the front end up, the clunk nearly, but not quite, touches the bottom of the tank at the center (see Fig. 3-5, page 14). The sketches in THE MANUAL that came with my kit show the clunk too far back in the tank. It could cause engine problems in that position, so make sure the clunk can never quite touch the back of the tank.

Isolating the tank from vibration: The fuel tank sketches that came with my kits show the front end of the tank pressed against the plywood fire wall. This is asking for engine trouble. In-

FIG. 12-12 20T RUDDER PUSHROD SLOT



Because of an awkardly placed former in the 20T tail, the placement of the rudder pushrod slot and the shape of the pushrod are critical. Cut the slot as shown here. It should be ⅛" wide.

Fig. 12-11. You may have to ream the tank opening slightly to fit the clunk through it.

stall the tank as shown in Chapters Four (Preliminary Radio Installation) and Six (Post-Covering Assembly).

Hold-down dowels: Use longer dowels than supplied with the kit. Cut your own from 5/16" stock. They should project 7/8" to 1" from each fuselage side. See Chapter Six (Post-Covering Assembly) on this subject.

Engine installations: I didn't believe the engine installation shown in THE MANUAL would work, but on the 40T it did, and just fine. On the 20T the installation was the same; however, the mounting screws had a tendency to loosen up every few flights. I suggest you apply LocTite to the mounting screws when you install them for the last time. The engine-mounting procedure itself is clearly explained in THE MANUAL.

Wheel installation: If the wheels fit their axles too tightly, ream out the hubs as described in Chapter Six (Post-Covering Assembly).

THE MANUAL shows only one wheel collar per wheel. Unfortunately, the 20T main gear axles are so short this is the best you can do. However, you should use two collars per wheel on the 20T nose gear and on all wheels on the 40T.

TAIL INSTALLATION

Before installing the tail, complete the work in Chapter Four (Preliminary Radio Installation). Then see Chapter Six (Post-Covering Assembly) for instructions on how to do it. You can skip everything THE MANUAL says on the subject and follow the procedures in Chapter Six with this addition: The elevator pushrod exits through a small hole in the rear of the fuselage, which raises the possibility of control failure if the clevis should hang up in that hole. To avoid any problem, cut away enough of the rear of the fuselage to allow the clevis to operate outside the airplane at all times. On the 20T this surgery will weaken the fuse sides under the stab, so reinforce those areas with balsa sheet.

RUDDER PUSHRODS

If you're building a 20T, cut the slot for the rudder exactly as shown in Fig. 12-12. Otherwise the rudder throw will be limited by the pushrod hitting a rear former inside the fuselage.

FINAL RADIO INSTALLATION

Follow the instructions in Chapter Seven (Final Radio Installation). Ignore THE MANUAL'S instructions on this topic.

BALANCING THE AIRPLANE

When balanced at the forward end of the range given in THE MANUAL, my planes flew poorly. Balance the 20T 3¾" behind the leading edge of the wing and the 40T 4½" behind the leading edge. Chapter Eight (Final Touches) provides more on balancing.

13. Building the Top Flite Headmaster

Build the Top Flite Headmaster according to instructions in THE MANUAL with the following exceptions, additions, and clarifications.

THE WING

Gluing the dihedral brace: THE MANUAL tells you to epoxy the three pieces of the dihedral brace together and weight them down until the epoxy cures, but I recommend a different method. Clamp them together with C-clamps or a vise, using waxed paper to keep from gluing metal to wood. Make sure all three pieces are aligned, then clean off excess glue with an alcohol-soaked tissue and allow the epoxy to cure (see Fig. 12-1, page 59).

Fitting the dihedral brace: Once the brace is glued together, mark one side "front" and draw a vertical center line on it (see Fig. 12-2, page 59). Mark one side of the brace "right" and the other side "left." Test fit the brace into the slot in the appropriate wing panel. It should go in at least to the center line.

If it doesn't, trim the end until it does. Repeat the procedure using the other wing panel. Now dry-fit the two panels together over the brace. The center ribs should fit flat together and the leading and trailing edges of one wing should line up perfectly with the leading and trailing edges of the other wing. If necessary, trim the brace, slot, or both to obtain this fit.

Joining the wing panels: This is a two-part procedure. First you epoxy the brace into one wing and let the epoxy cure, then you epoxy the second wing panel over the brace and flush against the first panel. Read the entire procedure before you glue anything and assemble everything you'll need within arm's reach. Do at least one dry run before mixing any glue. You'll have a limited amount of time to get it right, and if you don't, you could end up with a useless wing. Here's the procedure.

Mix up a batch of 30-minute epoxy (don't use a faster epoxy!). Smear some over the right or left half of the brace and into the slot in the corresponding wing. Insert the brace into the slot at least to the center line and jiggle it around a few times to get epoxy on every bit of wood in the slot. If this joint fails, your plane returns to kit form, so be sure the epoxy wets all the wood.

Remove the brace, drop more epoxy into the slot, smear more onto the brace, then slip the brace back into the slot, aligning the center line with the wing center rib. Finally, clean excess epoxy off the protruding part of the brace, wing rib, and wing surface with tissues soaked in alcohol, then set the assembly aside to cure completely.

Next, using essentially the same procedure, epoxy the second wing panel over the brace and flush against the first panel. The major difference here is that this time you need to smear epoxy over both center ribs.

Once the wing halves have been glued together, check to be sure the leading edge and trailing edge of the right wing line up perfectly with the leading and trailing edges of the left wing and that the center ribs fit flush against one another. Cover the center joint with the tape provided in the kit, check the alignment one more time, then set the wing aside to cure. The easiest way to do this is to stand it on end in an out-of-the-way corner. Just

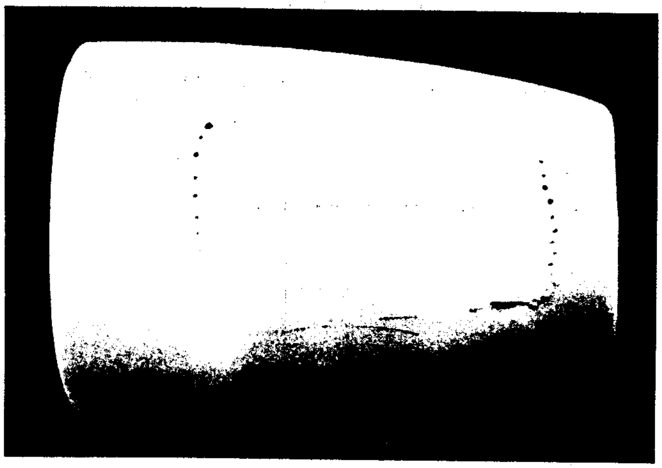


Fig. 13-1. It's easier to cut the cowl if you first outline the cut by drilling ⅟₁₆" holes.

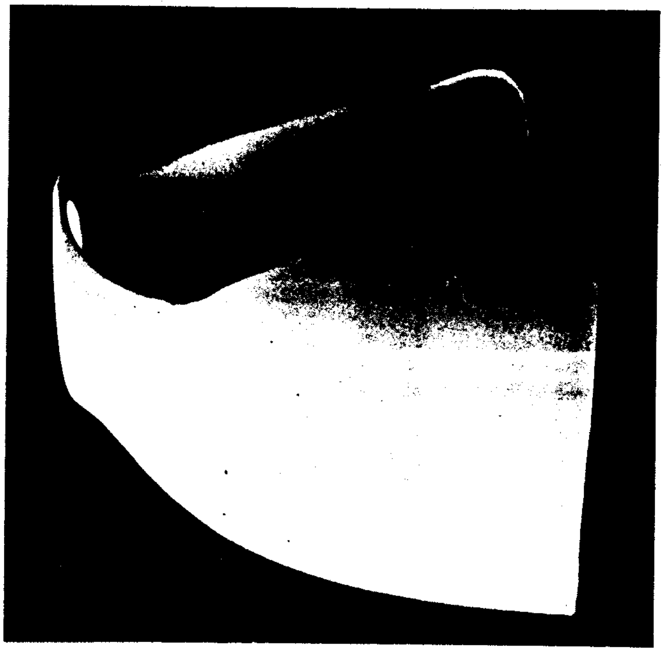


Fig. 13-2. Enlarge the hole with your modeling knife until it will accommodate the engine.

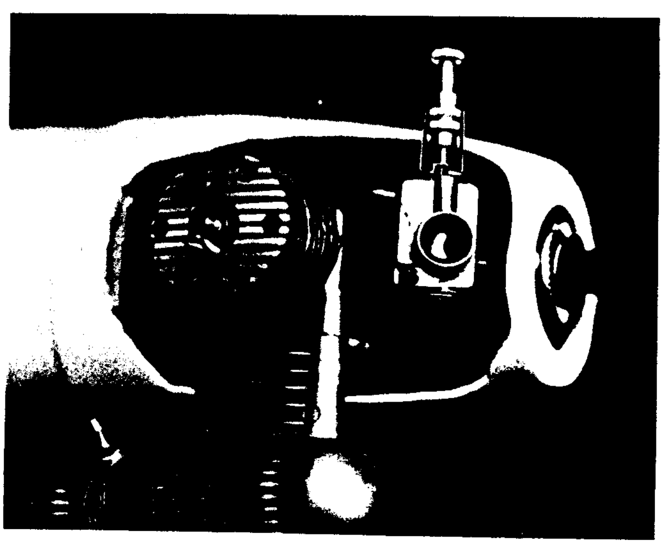


Fig. 13-3. The finished opening should fit like this.

SPECIFICATIONS FOR THE TOP FLITE HEADMASTER

Test Plane Specifications

Wingspan: 59½"
Wing area: 714 square inches
Weight: 92 ounces (5 pounds, 12 ounces)
Wing loading: 18.6 oz. per square foot
Radio: Futaba Conquest 6-channel (4 channels used)
Engine: K & B .40 two-stroke (but use larger engine)
Propeller: 10/6 Top Flite

Setup Recommendations

Controls: 4 channels — elevator, rudder, throttle and ailerons. DO NOT FLY THIS PLANE WITHOUT AILERONS!
Dihedral angle: Set up as described in THE MANUAL.
Balance point: Balance 3½" aft of the leading edge of the wing.
On-board electronics and pushrod arrangements: Arrange these items as shown in the accompanying drawing, not as shown in the photo in THE MANUAL. Do not use the pushrods provided with the kit; you can make better ones. See Chapter Four (Preliminary Radio Installation) for details.
Control throws: Set the control throws as recommended in THE MANUAL. The ailerons may be touchy for you. If you find yourself overcontrolling, reduce the throw a little at a time with the advice and assistance of your instructor. If your Tx has rate switches and you fly on low rate, you can just dial in throw changes as needed.

General Hardware and Materials Sizes

Fuel tank: Use the tank supplied with the kit.
Wheel collar: ⅛₂"
Engine: .45 two-stroke. I used a smaller engine on my Headmaster, but takeoffs from grass on hot days were dicey. The plane needs a .45 engine for best performance. You can and should throttle back after reaching cruising altitude.
Propeller: 10/8 or 11/6
Spinner: Use the spinner that comes with the kit.
Wheels:
Main Wheels: 3"
Nosewheel: 2¼"

Fire Wall Hardware

For attaching engine mount and nose gear bracket to fire wall, use the hardware provided in the kit. For mounting the engine, you'll need four 6-32 machine screws with washers and four 6-32 lock nuts with nylon inserts.

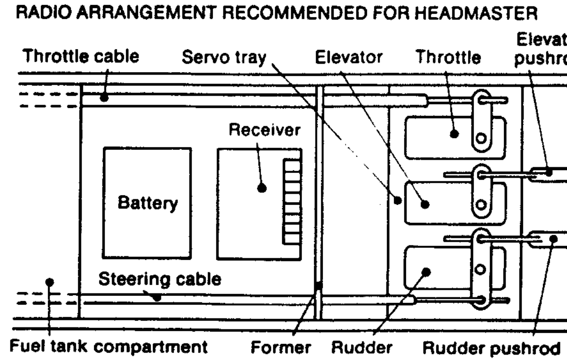
Pushrods

Metal pushrods with 2-56 thread at one end (quantity = 5)

Additional Materials

Light fiberglass cloth — two small strips for reinforcing the tank cover/windshield

RADIO ARRANGEMENT RECOMMENDED FOR HEADMASTER



Rather than jam everything in the front of the radio compartment, I placed the servo tray behind the former. My plane balanced perfectly that way.

NOTE: Place the battery as far forward as possible.

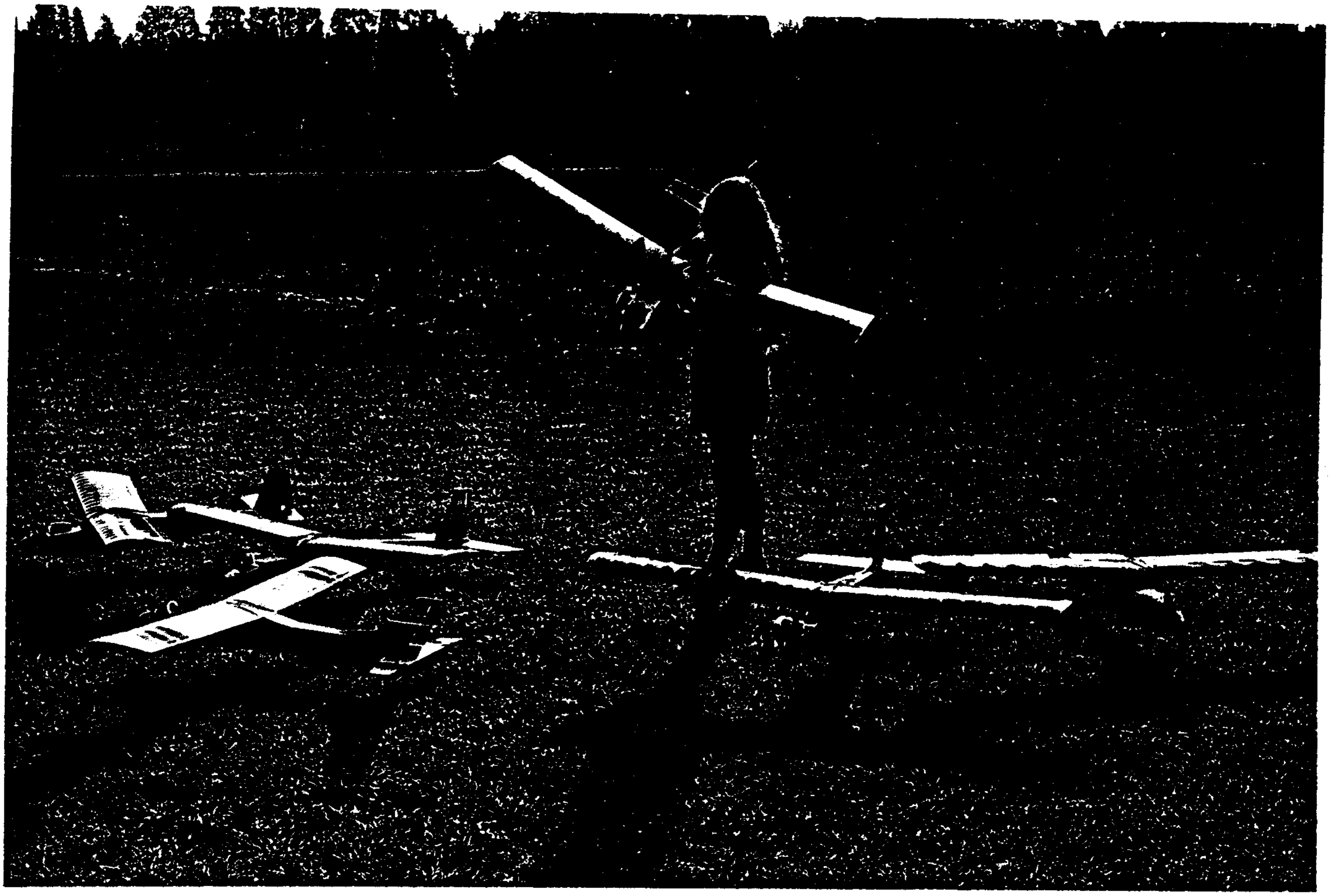


Fig. 13-7. A finished and ready-to-fly Top Flite Headmaster (far right) and some of the other planes discussed in this book.

be sure you don't disturb the alignment in doing so.

Preparing the ailerons: To accommodate the longer wing hold-down dowels I recommend, you'll have to cut ¼" off the inner end of each aileron. Make sure it's the inner end, not the tip. Do not hinge the ailerons now, and when you do, replace the hinges supplied in the kit with CA hinges and install them as described in Chapter Six (Post-Covering Assembly).

POSITIONING THE ENGINE ON ITS MOUNT

THE MANUAL says to place the engine so the rear of the spinner's backplate is 4½" from the front of the fire wall. The crankshaft on the engine I used was too short to give that much room, so I positioned the engine as far forward as possible and installed it as described in Chapter Four (Preliminary Radio Installation). Later, I had to install the plastic cowl farther back on the fuselage than the plans called for to clear the spinner backplate.

FUSELAGE CONSTRUCTION (STEERING ARM INSTALLATION)

Don't install the steering arm and nose gear when THE MANUAL tells you to. Follow the instructions in Chapter Four (Preliminary Radio Installation).

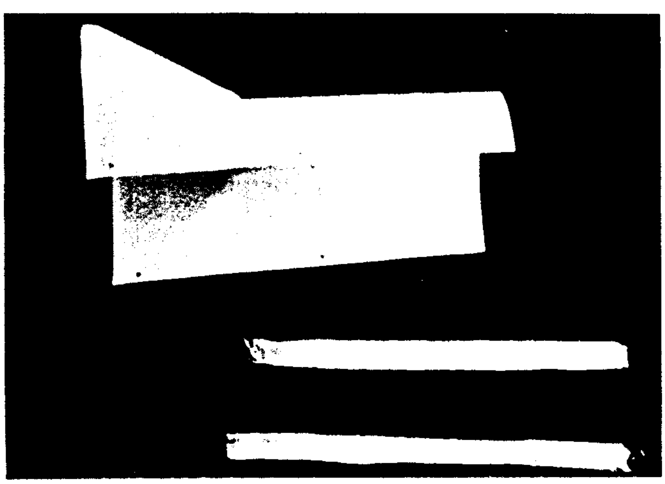


Fig. 13-4. Cut fiberglass strips to reinforce the windshield/tank cover.

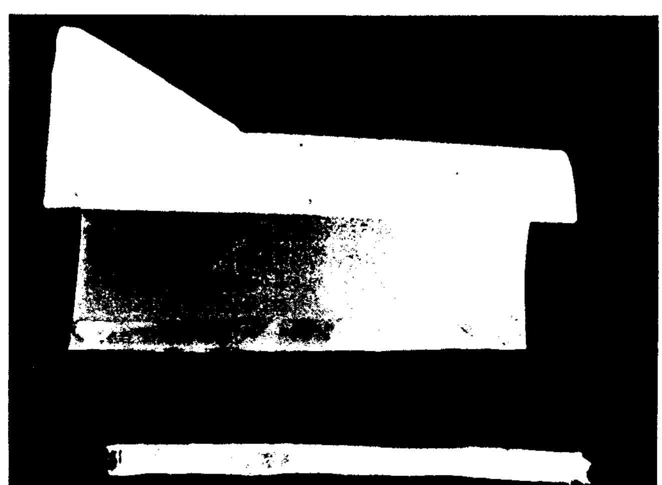


Fig. 13-5. Then, glue them in place with epoxy.

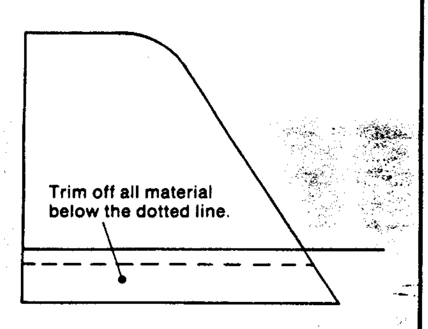


FIG. 13-6 TRIMMING THE FIN

On my Headmaster kit the fin as supplied was too long. I had to trim it as shown before installation to keep it from interfering with the elevator pushrod.

COWL MOUNTING BLOCKS

Install these as described in THE MANUAL.

CARVING THE COWL

Follow the instructions in THE MANUAL and see Figs. 13-1, 13-2, and 13-3. When installing the cowl, allow ⅛" between cowl and spinner, rather than the 1/16" prescribed in THE MANUAL.

INSTALLING THE WINDSHIELD/TANK COVER

Before installing this part, reinforce it with light fiberglass and epoxy (see Figs. 13-4 and 13-5). Then follow the installation instructions in THE MANUAL.

INSTALLING THE TAIL

Before installing the tail, complete the work in Chapter Four (Preliminary Radio Installation). Then work your way through Chapter Six (Post-Covering Assembly) where tail installation is covered in detail. Ignore everything THE MANUAL says and rely on THE BOOK.

There is one special problem with the tail on this plane. At least on the kit I built, the fin was so long it would have interfered with pushrod operation had I installed it "as is." If you find the same problem, cut the bottom of the fin so that when installed it will protrude below the fuselage top planking by no more than ⅛" (see Fig. 13-6).

SERVO, PUSHROD, AND STEERING INSTALLATION

Ignore THE MANUAL on these subjects. They're covered in Chapter Four (Preliminary Radio Installation) and Chapter Seven (Final Radio Installation). DON'T USE THE PUSHRODS SUPPLIED IN THE KIT. You can make better ones.

HOLD-DOWN DOWEL INSTALLATION

Replace the kit dowels with longer ones. These should be 5/16" in diameter and should protrude ⅞" to 1" from each fuselage side. See Chapter Six (Post-Covering Assembly) for details.

LANDING GEAR INSTALLATION

For the main gear, follow the instructions in THE MANUAL. For the nose gear installation, see the instructions in Chapter Four (Preliminary Radio Installation).

ALL RADIO INSTALLATION

Follow the instructions in Chapters Four (Preliminary Radio Installation) and Seven (Final Radio Installation).

FUEL TANK ASSEMBLY

The sketch in THE MANUAL shows the fuel line inside the tank longer than it should be. When you hold the tank with the outlets on top, the clunk should not quite touch the tank bottom. See Chapter Three (Miscellaneous Preliminaries) for more detail.

Useful Addresses

Academy of Model Aeronautics
1810 Samuel Morse Drive
Reston, VA 22090

Ace Radio Control, Inc.
P. O. Box 511, 116 W. 19th Street
Higginsville, MO 64037

Dave Brown Products
4560 Layhigh Road
Hamilton, OH 45013

Coverite
420 Babylon Road
Horsham, PA 19044

Cox Hobbies, Inc.
1525 East Warner Avenue
Santa Ana, CA 92705

Du Bro Products, Inc.
480 Bonner Road
Wauconda, IL 60084

Futaba Corp. of America
555 West Victoria Street
Compton, CA 90220

Carl Goldberg Models, Inc.
4732 West Chicago Avenue
Chicago, IL 60651

Great Planes Model Manufacturing
706 West Bradley Street
P. O. Box 721
Urbana, IL 61801

Hot Stuff/Satellite City
P. O. Box 836, 659 Laguna Drive
Simi, CA 93062

Midwest Products Co.
400 South Indiana Street
P. O. Box 564
Hobart, IN 46342

Pactra Coatings, Inc.
1000 Lake Road
Medina, OH 44256

Rocket City Specialties
103 Wholesale Avenue
Huntsville, AL 35811

Royal Products Corp.
790 West Tennessee Avenue
Denver, CO 80223

Sig Manufacturing Co., Inc.
401-7 South Front Street
Montezuma, IA 50171

Sullivan Products, Inc.
P. O. Box 5166
One North Haven Street
Baltimore, MD 21224

Top Flite Models, Inc.
2635 South Wabash Avenue
Chicago, IL 60616

Windsor Propeller Co.
384 Tesconi Court
Santa Rosa, CA 95401

World Engines, Inc.
8960 Rossash Avenue
Cincinnati, OH 45236

Special thanks to Eric Clapp and the rest of the folks at Doug's Hobbies.